Management and conservation of closed forests in tropical America

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PREFACE

The Forest Resources Division of FAO's Forestry Department has undertaken in recent years the publication of a series of Forestry Papers on the management of moist tropical forests in collaboration with various national organizations. The first of these documents presented examples of tropical forest management in India, Ghana, Honduras and Trinidad and Tobago (FAO Forestry Papers Nos 53 and 55). These were followed by regional surveys of forest management systems currently practiced in Africa and Asia, published in 1989 (FAO Forestry Papers Nos 88 and 89). This paper continues the series with a survey of the management systems implemented in the moist tropical forests of Latin America and the Caribbean.

This is the region that has the largest area of closed tropical forests in the world. As in most of the tropical world, the destruction of these forests is proceeding at a rapid pace. Although the great Amazonian forest is still largely intact, in spite of considerable deforestation on its outskirts, the maintenance of a sufficient amount of forest cover in other tropical parts of the continent is problematical, or even gravely compromised.

The management of tropical forests with a view to the sustained production of wood and/or other products and services is a *sine qua non* not only for their conservation but also for improvement of the quality of life of the millions of persons who live in or near these forests.

In the Amazon Basin countries, where population density is low, zoning based on solid scientific criteria should make it possible to direct land settlement towards the richest soils, to develop the permanent forests and to reserve a certain number of protected areas. Extensive, rather than intensive forest management should be envisaged in the initial phases of such development.

The Central American and Caribbean countries, on the other hand, have a high population density and are faced with wood supply problems. Their land reserves are limited and there is much soil erosion. In this context a policy based on the delimitation of permanent national productive forests is imperative, and must be accompanied by intensive forest management, possibly in association with agro-silvo-pastoral-activities.

We hope that this study will serve as a reference book for those interested in this subject, whether they be foresters or not, and that it will help them to understand more fully, and possibly also to solve, the problems posed in the management of tropical American forests.

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- "Informe relativo al manejo de bosques tropicales húmedos en México" - Miguel Caballero Deloya, Carlos Rodríguez Franco, Instituto Nacional de Investigaciones Forestales y Agropecuarias de México, Mexico.

- "El manejo de bosques húmedos tropicales en América Central" - Héctor A. Martínez, Ronnie de Camino, Centro Agronómico Tropical de Investigación y Enseñanza - CATIE, Costa Rica.

- "Management of tropical moist forest in Suriname" - J. Hendrison and W.B.J. Jonkers, Landbouw Hogeschool, Wageningen, Netherlands.

- "Rapport national sur l'aménagement des forêts naturelles tropicales humides en Amérique Latine", Office National des Forêts - ONF and le Centre Technique Forestier Tropical - CTFT, French Guiana.

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CONTENTS

		Page
I.	INTRODUCTION	1
	1. Previous papers	1
	2. Presentation	1
	3. Management and conservation	2
II.	EXTENT AND CLASSIFICATION OF CLOSED FORESTS IN TROPICAL AMERICA	5
	1. The tropical forests of Mexico and Central America	5
	2. The island forests - the Caribbean	9
	3. The Guyanese forest region	12
	4. The Amazonian forest region	15
III.	FOREST POLICIES, LEGISLATION AND ADMINISTRATION	25
	1. The Isthmus countries	25
	2. The Caribbean archipelago countries	28
	3. The Guyanese region countries	29
	4. The Amazonian countries	32
	5. Recapitulation	40
IV.	STATE OF THE RESOURCE: INVENTORIES AND DEFORESTATION	43
	1. The Isthmus countries	44
	2. Mexico	48
	3. Belize	48
	4. The Caribbean	49
	5. The Guyanese region	51
	6. The Amazonian countries	53
	7. General conclusions	56
V.	ECONOMIC FACTORS AND WOOD PROCESSING	57
	1. General introduction	57
	2. The Isthmus and Caribbean countries	60
	3. The Guyanese region countries	66
	4. The Amazonian and Andean countries	70

VI. RESEARCH 76

1. The Isthmus and Caribbean countries 76
2. The Guyanese region countries 79
3. The Amazonian and Andean countries 82
4. Overall summary of research 87

VII. MANAGEMENT PROGRAMMES AND PROJECTS 90

1. Overview 90
2. The Isthmus and Caribbean countries 91
3. The Guyanese shield countries 98
4. The Amazonian and Andean countries 101

VIII. CASE STUDIES 107

1. Case study N° 1 107
2. Case study N° 2 113
3. Case study N° 3 117
4. Case study N° 4 124
5. Case study N° 5 128
6. Case study N° 6 131

IX. GENERAL SUMMARY - CONCLUSION 133

BIBLIOGRAPHY 137

I. INTRODUCTION

1. Previous papers: With a view to the planning and preparation of tropical forest management and conservation programmes, the FAO Forestry Department has commissioned a number of papers on tropical moist forest management. The most recent and significant of these are:

"Review of forest management systems of Tropical Asia" (FAO FORESTRY PAPER 89) based on case studies of timber-oriented projects in India, Malaysia and the Philippines; and "Management of tropical moist forests in Africa" (FAO FORESTRY PAPER 88), which deals essentially with lowland tropical moist forests.

2. Presentation: This paper deals above all with low-altitude moist forests in Central America and Amazonia, and reviews the forest situation typical of most tropical Latin American nations and prevailing in the definition and application of Forest Management Plans.

It summarizes the available documents collected by the FAO Forestry Department. These are either national reports written expressly for the purposes of the present paper (as in the cases of Central America, Suriname, and French Guiana), or project reports or final assessments drawn up by various experts and participants (as in the cases of Brazil, Mexico, Venezuela, etc. ...).

For easier reading, in the following chapters the various countries have been grouped together in geographical blocs or sub-regions:

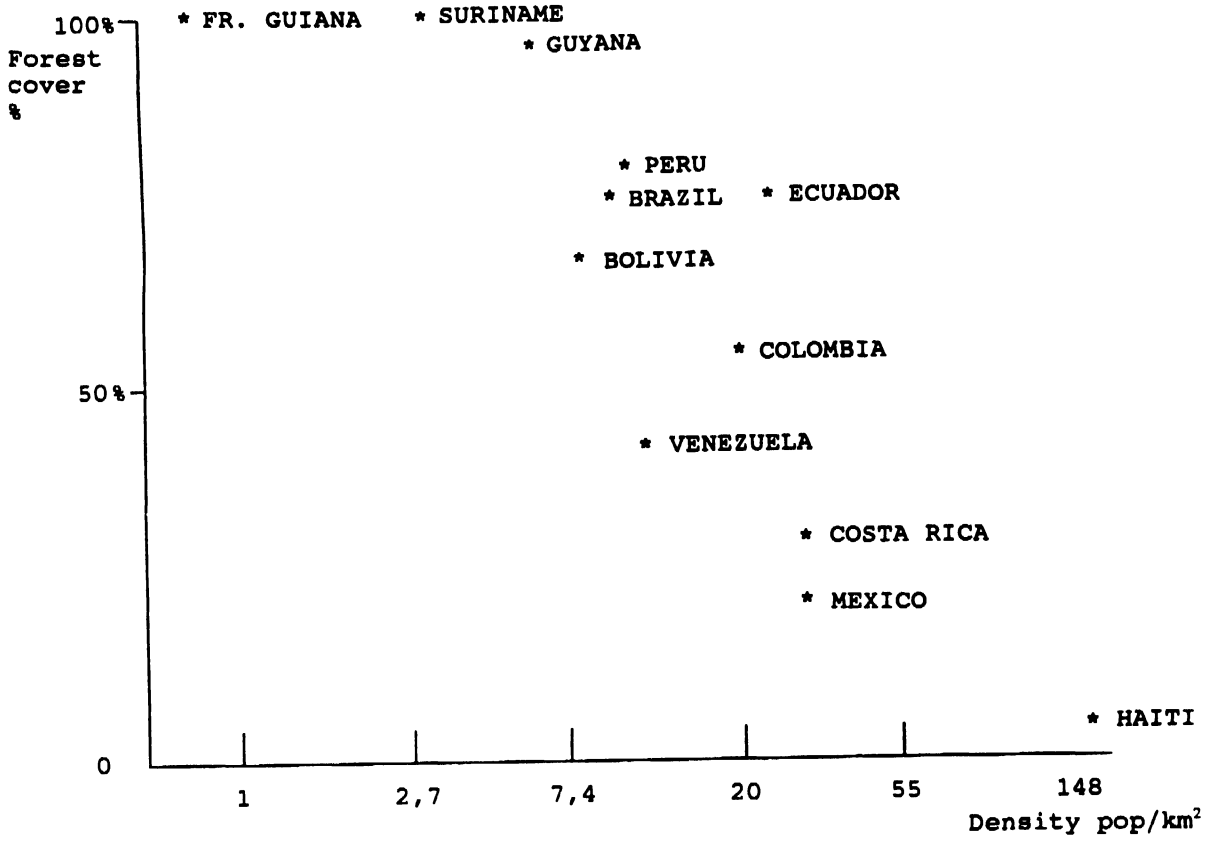
- The first, consisting of Mexico, the Central American Isthmus countries and Belize, constitutes a relatively homogeneous unit whose natural forest formations are presented in greatest detail in the section on Mexico;

- The second is the Caribean Archipelago, an area on which only scanty data is available in many cases;

- The next group consists of Suriname, Guyana and French Guiana (including Venezuelan Guyana) which due to their size and their inclusion in the Guyanese Shield are somewhat aloof from the Amazonian forest region;

- The last group is made up of all those South American nations that include portions of Amazonian forest, namely Brazil, Bolivia, Colombia, Ecuador, Peru and Venezuela; the most detailed presentation of these forest formations is given in the section on Brazil.

These groupings are further justified by the concept of an interactive relationship between forest cover and deforestation, the latter being directly related to population density per km^2. The graph shown below (taken from "Deforestation or development in the Third World?" MATTI PALO & JURKI SALMI 1987, The Finish Forest Research Institute), which establishes the correlation between forest cover and population density in Latin America in 1980, is extremely eloquent:



The Guyanese Shield countries are grouped together in the sector with low population density and high rate of cover, whilst Costa Rica (Isthmus) and Mexico are in the opposite sector (high population density and low forest cover); most of the Amazonian countries are midway between the two.

(Attention is drawn to the dramatic situation in Haiti).

Note: So as to preserve the consistency (and primary motivation) of this paper, namely natural forest, its conservation and development, we have decided to omit, or rather, to avoid dealing at any length with man-made forest plantations (and their silvicultural techniques), which are certainly very numerous and would have taken up a disproportionate amount of space in the text, although in the last analysis they merely constitute a technical alternative when the natural forest ecosystem can no longer be sustained.

3. Management and conservation: There can be no doubt that one of the best ways to protect a forest is to work in it; more specifically, continuous and permanent forest management combines all the crucial elements required to assure forest conservation, and this is even more true when these measures are able to give rise to positive economic, ecological, social and scientific repercussions.

The definition (or definitions) of forest management is presented in some detail in the introduction to the aforementioned FAO Forestry Paper 88 on Africa. A few brief quotations should thus be sufficient for our purposes:

"Management consists in deciding what we wish to do with the forest, to take account of what we can do with it, and hence to deduce what we should do with it".

"(Management is) the allocation and organization of scarce resources to meet defined objects, goals or ends".

Both these definitions stress the fact that management must be a compromise between the ideal and the possible; that it requires clearly defined objectives; that the objectives must be realistic and may need to be modified in the light of biological, social economic or political constraints; and that management must make the best use of available resources.

The "traditional" approach to forest management was based essentially on the concept that the forest is an ecosystem to be described (geographical, climatic, floristic, pedological, ... ecological characteristics), studied (potential, evolution, growth ...) and situated in a specific context (ownership rights, produce, demand, markets, ...). Social data was rarely taken into account: except for human resources to carry out the work required, the socio-economic role and above all the impact "of" and "for" the surrounding population were scarcely or too briefly considered.

Once the above information had been obtained, the management plan prescribed the appropriate silvicultural techniques, rotations, felling rates and schedules, with estimated yields, ... and then proceeded to establish the procedures for verifying the application of the management plan and for its revision further on in the light of changing circumstances.

This rigorous standard approach, with its emphasis on long-term production, is in fact hardly ever applicable in the tropics, and particularly in tropical America, since it comes up against two major factors that imply a shift in its concepts and criteria:

- the high population growth-rate in most of the countries in question, and its consequences in terms of land-hunger and deforestation;

- and the constantly increasing demand in these countries for forest produce (chiefly wood).

Consequently, the criteria employed in drawing up "modern" Management Plans for tropical forests must obligatorily take into account the need to satisfy the local population's land and forest product needs, and knowledge of the forest ecosystem, its evolution, potential and development options will remain sterile unless accompanied by detailed analysis of pertinent agricultural, political and social factors.

Hence, quoting once again from FAO FORESTRY PAPER 88, the planning of management systems for the conservation and development of tropical forests must include at least four data sectors:

(1) Physical, biological and ecological factors;

(2) Social factors, including political and cultural facets, and local and national needs;

(3) Economic factors, including financial and budgetary constraints, rate of return, costs, prices, trade and markets;

(4) Technological factors and their rate of change in silviculture, harvesting and wood processing.

II. EXTENT AND CLASSIFICATION OF CLOSED FORESTS IN TROPICAL AMERICA

Continental and insular tropical America counts about 678 million hectares of moist forests, over half of which is located in the Amazon basin (see Map of Tropical Tree Formations overleaf).

In addition, there are also 108 million hectares of so-called secondary forests (CATIE, 1991).

1. THE TROPICAL FORESTS OF MEXICO AND CENTRAL AMERICA

Mexico has 38.9 million hectares of forest, equivalent to 19.4% of the country's total area, 11.4 million hectares of which consist of tropical tree formations. These are divided into two major groups, the so-called "high" forests: 2.1 million hectares, and "low" forests: 9.3 million hectares.

Apart from stands of Pines, the tropical broadleaved forests of Mexico vary considerably according to such distinguishing site characteristics as climate, e.g. rainfall, its distribution over the year and the number of dry months, and the edaphic and topographic factors, e.g. soil characteristics, altitude, slopes, etc.

In relation to these site characteristics, three major types of high forests can be distinguished that combine climatic and edaphic conditions favourable to forest ecosystem dynamics:

. Evergreen forest, (perennifolia) with non-deciduous leaves, under annual rainfall exceeding 2 000 mm with a short, dry season, or rainfall that continues without interrruption throughout the year and totals between 1 600 and 1 700 mm.

It is found at low altitudes on well-drained soils of volcanic, sedimentary or other origin. This is the most luxuriant type of forest, well-storeyed and including trees of all size classes.

The tallest trees in the dominant storey can exceed 60 metres in height and attain an above-buttress diameter of 60 cm. As in the upland Amazonian forest, most trunks are straight and free of low branches.

This type of forest is also richly endowed with species of commercial value. The best-known of these are:

- *Swietenia macrophylla* and *Cedrela odorata*	Meliaceae
- *Ceiba pentandra*	Bombacaceae
- *Guatteria anomala*	Annonaceae
- *Manilkara zapotilla*	Sapotaceae
- *Simarouba glauca*	Simaroubaceae

- *Vochysia hondurensis*	Vochysiaceae
- *Dialium guianensis*	Leguminosae
- *Terminalia amazonia*	Combretaceae

It is found almost exclusively on the Atlantic coast (except for a small strip on the Pacific side).

. Semi-evergreen forest (subperennifolia), in which some species (25 to 50%) shed all or much of their foliage during the three-month dry season.

It grows on sloping ground and on fairly poor calcareous or metamorphic soils, under annual rainfalls of 1 100 to 1 300 mm.

In this type of forest, which is far less well-stocked with valuable species than the previous kind, the dominant tree height is variable but relatively low: from 25 to 35 metres. The typical species are:

- *Brosimum alicastrum*	Moraceae
- *Astronium graveolens*	Anacardiaceae
- *Guarea turchemimii*	Meliaceae
- *Manilkara zapotilla*	Sapotaceae
- *Bursera simarouba*	Burseraceae
- *Platymiscium yucatanum*	Leguminosae
- *Pseudobombax ellipticum*	Bombacaceae

This is certainly the most widespread type of tree formation in Mexico; it grows only on the Atlantic seaboard.

. Semi-deciduous forest (subcaducifolia), in which 50 to 75% of the dominant species shed all their leaves during the lengthy stretch of five ecologically "dry" months. Annual rainfall is 1 000 to 1 200 mm. Although the density of the tree population is less than in the previous two types of forest, the dominant height is considerable: 25 to 30 metres.

This is a highly characteristic formation, found chiefly on the Pacific seaboard, which includes species of great commercial value:

- *Cedrela odorata and Swietenia humilis*	Meliaceae
- *Enterolobium cyclocarpum*	Leguminosae
- *Bernoullia flammea*	Bombacaceae
- *Pseudobombax ellipticum*	Bombacaceae
- *Maclura tinctoria*	Moraceae
- *Spondias monbin*	Anacardiaceae
- *Piscidia communis*	Leguminosae
- *Vitex gaumeri*	Verbenaceae
- *Cordia alliodora*	Boraginaceae

TROPICAL FOREST FORMATIONS

In addition, under poorer site conditions, a further four types of low forest are to be found which are to be considered structural and floristic variants on the previous three:

. Montane "low" evergreen forest: this type, which is found at altitudes between 1 000 and 2 500 m, is a moist forest ecosystem that grows under an annual rainfall of 1 500 mm accompanied by mists and invisible precipitations, and hence by abundant mosses, ferns and ground and tree-borne lichens. The soils are shallow and poor in humus; the trees are mostly small and misshapen. This type of forest, which contains some highly characteristic species such as *Podocarpus reichei*, is of no commercial interest, but plays a vital environmental role (erosion prevention, watershed protection, etc.).

. Two types of "low" semi-deciduous forest, strictly dependent on edaphic factors:

- Savanna or transitional forest/savanna formations of low density and floristic variety, in which tree height seldom exceeds 5 m;

- Swamp forests (growing on permanently or seasonally flooded land), in which three typical species account for most of the tree population: *Metopium brownei* (Anacariaceae), *Cameraria latifolia* (Apocynaceae) and above all *Heamatoxylum campechianum*, a Leguminosa formerly used to make dyes. This type of formation is very widespread on waterlogged soils in Yucatan.

. Lastly, the low deciduous forest. The geographical distribution of this type of forest is very complex: it is generally found on the slopes of deep, narrow valleys, on poor, stoney, sandy soils. It receives an average rainfall of only 800 mm per year and endures a dry season lasting 7 or 8 months, during which the species shed their leaves completely (5 to 7 months). The trees do not exceed 10 m in height and are often badly shaped and branchy at the base. Two frequently found species are *Bursea simarouba* (Burseraceae) and *Guiacum sanctum* (Zygophyllaceae).

Range in Central America

These formations extend beyond the country's borders and are found throughout the length of the Central American isthmus. Their ranges in this area vary considerably, but there is a very marked division between moist evergreen forests on the Atlantic seaboard and semi-deciduous and deciduous forests on the Pacific seaboard; these are separated by the central mountain ranges which enclose moist montane forests, stands of pines as far south as Nicaragua or oaks (*Quercus*. spp.) as far as south Costa Rica.

In Panama and Costa Rica, however, some characteristic formations of Catival and of Guandal/Sajal are found that are identical to those in Colombia (described further on).

Purely as an indication, the estimated forest areas in 1980 are given below (in millions of hectares):

	Broad-leaved forest	Coniferous forest	Total
Costa Rica	1.64	-	1.64
Salvador	0.10	0.04	0.14
Guatemala	3.78	0.66	4.44
Honduras	1.86	1.94	3.80
Nicaragua	4.17	0.33	4.50
Panama	4.16	-	4.16
TOTAL	15.71	2.97	18.68

Today these areas are undoubtedly far smaller; unfortunately the recent information available in this regard is fragmentary and unspecified due to the lack of up-to-date forest inventories.

As regards BELIZE, this sparcely populated country (average 8 inhabitants/km^2) is almost entirely covered with forests, which total slightly less than two million hectares. Three types of formation are found here (FAO Nicolait, 1984):

- firstly, moist broad-leaved forest, located on the lowlands in the Northeastern half of the country (1 600 000 hectares); it is extensively logged for the export market, and supplies large quantities of mahogany;

- secondly, natural pine-forests located in the mountains of the Southeastern half of the country and threatened by repeated forest fires (in areas where rainfall ranges from 2 000 to 3 000 mm per year); these, together with open forests, cover less than one hundred thousand hectares;

- lastly, mangrove and swamp forests: 240 000 ha.

2. THE ISLAND FORESTS - THE CARIBBEAN

The information available on the various islands of the Greater and Lesser Antilles constituting the Caribbean Archipelago differs considerably with regard to the extent and classification of natural tree formations (and even plantations and forestry activities).

Detailed coverage of this area is consequently impossible, and in the following pages we have therefore presented only the main data available, emphasizing the fact that the various sources tally above all with regard to the relative extent of the forest formations and their utilization.

In fact the forest cover rate ranges from dangerously low (as in the case of Haiti) to relatively high with accompanying development programmes and/or very advanced protection measures (as in that of Trinidad); these diverse situations are chiefly the result of difference in history, population density and standard of living.

PUERTO RICO

The total area of climax forests is estimated to be only 3 400 hectares. All the rest of the island has, to a greater or lesser degree, been affected by human intervention, and particularly by tree-felling.

The total forest area is 279 000 hectares, equivalent to a cover rate of 31%, and the productive forests cover 130 000 ha, as classified in 1973 using Holdridge's "Life zone system". The forests in question are of the "subtropical" type:

- Mangrove and swamp forests, with heights varying according to rainfall.

- Subtropical dry forest, under rainfall of 600 to 1 100 mm. The species are deciduous, with succulent or coriaceous leaves. The dominant height is around 15 metres and the growth-rate is low, giving generally hard woods. The crowns are broad and flattened, with sparse foliage. This type of forest usually grows on calcareous soils.

- Subtropical semi-moist forest, with rainfall between 1 100 and 2 200 mm. The trees have rounded crowns, with a total height exceeding 20 m. Many species are deciduous and there are numerous epiphytes. The stands have frequently given way to grazing.

- Subtropical moist forest, with rainfall between 2 000 and 4 000 mm. The forest canopy, located at a height of approximately 20 m, is very thick. Epiphytes and orchids are numerous.

- Very moist subtropical forest, with precipitations exceeding 3 800 mm and soil permanently saturated with water. The original feature of its floristic composition is the presence of palms.

- Montane forest: the last remnants of climax forests (3 400 hectares).

- Plantations extending over 11 200 ha of state forests and 27 000 ha of private forests. The most commonly used species are Pines, Eucalyptus, Teak and Mahoganies.

- Lastly, mangrove swamps and swamp forests (about 6 000 hectares).

CUBA

On this island, the largest in the Caribbean, the natural forests are confined to the three mountain ranges: the Cordillera de los Organos y Sierra del Rosario in the West, the Sierra Trinidad in the Centre and the Sierra Maestra in the East.

The available figures are approximative: the area covered by mangrove was about 400 000 hectares in 1975, and apart from areas of severely degraded forest, the formations in the mountainous areas cover around 800 000 hectares.

Taking into account the fact that Pine formations and plantations could well amount to a further 200 000 hectares, the proportion of forest cover would thus be between 10 and 12%.

The types of upland closed forests vary according to rainfall and soil characteristics (the valuable species include *Swietenia mahogany*, *Swietenia macrophylla*, and *Cedrela mexicana*).

The pine formations include many different species: *Pinus tropicalis*, *P. cubensis*, *P. caribaea* and *P. occidentalis*.

HAITI AND DOMINICAN REPUBLIC

Broadleaved forests are found only at high altitudes in Haiti and can be classified as "residual" subtropical moist forests. The forest cover rate is alarmingly low: about 1%!

The situation is less serious in the Dominican Republic, where the forest cover rate in 1985 was estimated at 12%.

The forest stands, which cover only the poorest soils, are floristically akin to those of Cuba (subtropical climate). Swietenias, Cedrelas and Simarubas are present, and a few pines (*Pinus occidentalis*) are to be found mixed in with the broad-leaved species.

JAMAICA

Compared to those of the preceding countries, Jamaica's plant formations are distinctly tropical, but the forestry situation is similar: a forest cover rate of 5% in 1985 (it is noted that reforestation is being attempted, as is also the case in Cuba).

MARTINIQUE, GUADELOUPE AND DOMINICA

In spite of the high population density, managed and/or protected state-owned forests (including 1 500 ha of plantations and 2 000 ha of mangrove swamps) cover 12 000 hectares in Martinique, equivalent to 11% of the island's total area, without taking into account the 25 000 hectares of privately-owned forest lands.

Guadeloupe has 30 000 hectares of state-owned forests (including 5 000 ha of mangrove swamps and 4 000 ha of plantations), concentrated in the Basseterre Peninsula (17% of the island's total area).

Lastly, the island of Dominica, which has a low population density, has an exceptionally high rate of forest cover.

Note: in the Lesser Antilles the high rate of endemic species deserves mention.

TRINIDAD AND TOBAGO

The forest of Tobago, and above all that of Trinidad is in all respects (structure, flora ..) similar to the great Guyanese forest, and especially its Venezuelan portion. This applies particularly to the moist evergreen forest. The two species typical of the latter are *Carapa guianensis* and *Eschweilera subglandulosa*. This type of forest accounts for much of the forest cover: 115 000 hectares according to the inventory completed in 1980.

The semi-deciduous forest (14 000 ha) is characterized by species such as *Peltogyne porphyrocardia*, *Tabebuia serratifolia*, etc. The dry forests, deciduous or evergreen, are marginal (4 500 ha). Moist montane forests cover only 22 000 hectares.

With the inclusion of swamp and mangrove forests as well as forest plantations (16 500 ha in 1980), the total wooded areas of Trinidad and Tobago amount to 200 000 hectares, giving a cover rate of 39%.

Note: It must be emphasized that Trinidad and Tobago are an exception in the American tropical forest context; their outstanding forestry expertise and programmes (Synnot T. 1988) will be described further on.

3. THE GUYANESE FOREST REGION

The Guyanese forest can be distinguished phytogeographically from that of the Amazon basin for several reasons: it constitutes a fairly homogeneous unit from the climatic and geological/pedological standpoints (Guyanese shield), and above all from the floristic point of view; it covers a vast coastal fringe of the South American continent stretching from Venezuelan Guyana (including Trinidad) to the State of Amapa in Brazil and including Guyana, Suriname and French Guiana.

In spite of the damaging impact of human activities on forests in recent years (Venezuela, Guyana ...), this forest unit is still relatively unpopulated and unharmed.

VENEZUELA

There exists a very exhaustive cartographic document that classifies the various types of vegetation found in this country, namely the "Mapa de vegetacion actual de Venezuela", published in 1983. It is based on the cross-analysis of nine types of data (type of formation,

evergreen or deciduous foliage, altitude, stand density and tree height, morpho-pedology, human impact, agriculture and hydrology) and has resulted in a very detailed typological study of the bioclimatic landscape.

The total area covered by plant formations (consisting of trees and/or shrubs, and extremely varied) exceeds half the national territory, with moist forests proper accounting for around 30 million hectares, 90% of which are concentrated in the East of the country on both sides of the Orinoco in the Guyana Venezolana region. As its name indicates, this very extensive Eastern forest zone is floristically and structurally linked to the Guyanese shield formations, with varieties of some characteristic species - *Peltogynes, Hymeneas* or *Eperuas* - appearing in the midst of extremely heterogeneous forests that average sixty different species per hectare, with 600 stems exceeding 10 cm in diameter and a basal area of 20 to 35 m^2.

The composition of these forests is very accurately described in the document entitled "Especies forestales autóctonas de los bosques naturales de Venezuela", published by J.P. VEILLON in 1986.

According to B. Blasco (1991), Venezuela is amongst the world's eight major mangrove countries, four of which are in America:

- Brazil 2.5 million hectares (estimated)
- Venezuela 0.6 million hectares
- Panama 0.2 " "
- Colombia 0.3 " "

SURINAME

Forest vegetation covers 92% of the total area of the country. The primary forests can be divided into five classes:

- mangrove swamp (115 000 ha),
- fresh water swamp forest (725 000 ha),
- seasonal swamp forest (505 000 ha),
- dry forest (150 000 ha),
- moist upland forest (13 362 000 ha).

Secondary forests and other plant formations cover 170 000 ha.

- Mangroves protect the coasts from erosion. They are composed chiefly of species belonging to the *Rhizophora* and *Avicennia* families, and although they can provide good-quality fuelwood they are only minimally exploited.

- Seasonal fresh water swamp forest is very common on the coastal lowlands. One of the three sub-types, characterized by an abundance of *Virola surinamensis*, *Symphonia globulifera*, *Pterocarpus officinalis* and *Euterpe oleracea* (a palm), is of commercial importance. This type of forest exceeds 40 m in height and grows on peaty soils that may seasonally dry out on the surface.

- The permanent swamp forests vary greatly in floristic composition, and have many species in common both with the seasonal swamp forests and with the moist upland forests. Large-scale exploitation occurs in the West when *Mora excelsa* is dominant and on the coastal plain when *Hura crepitans* is dominant. The other species of commercial interest are *Carapa* spp. and *Tabebuia serratifolia*, which can reach a height of 45 m.

- The dry forests grow on white sands and highly filtering soils. Two sub-types are distinguished according to tree height:

. low dry forest, with few species and a height of less than 15 m;
. high dry forest, which is far more varied and taller (30 m). The typical species is *Eperua falcata*, but it has many species in common with the moist upland forest. Commercial exploitation is feasible when sufficient quantities of marketable woods are present.

- Moist upland forests cover over 80% of the country. As in French Guiana, De Granville (1987) distinguishes two sub-types according to altitude, the dividing line being at around 400-600 m. The soils are generally very poor and well-drained. These forests are botanically rich, but somewhat less varied than the world's other evergreen forests. About 500 species have been identified and an average of between 100 and 150 species are found per hectare. Some 70 species are currently or potentially of commercial interest, including in particular:

- *Goupia glabra*
- *Dicorynia guianensis*
- *Vouacapoua americana*
- *Ocotea rubra*
- *Virola melinonii*

The forest structure is variable and the canopy height is between 28 and 45 m.

FRENCH GUIANA

As in Suriname, proceeding from the coast towards the interior the following plant formations are encountered:

- A coastal fringe of mangrove swamp featuring *Avicennia nitida* along the sea-coast and *Rhizophora* spp. in the estuaries;

- A strip of grassy savanna, probably partly of man-made origin, which is the focal point of human activities;

The great Guyanese forest, consisting of equatorial moist evergreen forest and covering over 8 000 000 ha (90% of the country). It is divided into several subtypes:

Low-altitude swamp forests located along watercourses on seasonally flooded ground. The typical species are *Virola surinamensis, Symphonia globulifera* and *Carapa procera.*

Low-altitude upland forest (below 500 m). This constitutes the greater part of the great Guyanese forest. Its typical features are great botanical variety, scattered and isolated individuals of the same species and relatively small tree size, particularly as compared to African forests. The most common botanical families are Leguminosae, Lecythidaceae, Vochysiaceae and Sapotaceae.

Medium-altitude forest (above 500 m), located chiefly along the ININI-CAMOPI range. Its floristic composition features a rather limited range of tree species and a relative abundance of latex-bearing species, especially Sapotaceae. Tree-ferns such as *Cyathea imrayana*, which can attain a height of several metres, are scattered through the forest.

4. THE AMAZONIAN FOREST REGION

This chapter describes not only the Amazonian forest proper, but also the Pacific coastal forests and Brazil's Atlantic forest.

The Amazon basin extends over 750 million hectares, 350 million of which are located in Brazil.

Around 280 million hectares of the Amazonian closed forest proper are in Brazil, i.e. over half its total area, which is estimated at about 500 million hectares including the portions extending into Bolivia, Colombia, Equador, Peru and Venezuela, and the Guyanese forest as well.

BRAZIL

In spite of its complexity and diversity, THE AMAZONIAN FOREST can be subdivided into three major types of formation, which differ greatly in extent:

- moist upland forest, which constitutes most of the Hylaea;
- the fresh water swamp forests, the chief of which are the Varzea (seasonal flood-water swamps) and the Igapo (permanent swamps); and
- the transitional forest growing between closed moist forest and savanna formations. The precise boundaries of this type of forest are hard to define.

brasiliense (Guttiferae), *Simaruba amara* (Simarubaceae) and some Leguminosae, such as *Hymenaea stilbocarpa*; whilst in eastern Parà and in certain areas of Maranhao the species indicated below are reported:

Lecythis paraensis	Lecythidaceae
Bertholletia excelsa	Lecythidaceae
Ceiba pentandra	Bombacaceae
Castilloa ulei	Moraceae
Hymenea courbaril	Leguminosae
Vouacapoua americana	Leguminosae

THE ATLANTIC FORESTS

These forests are vividly described by Aubréville (1961): "In the past, an unbroken belt of forest stretched along the Atlantic Ocean coast from Brasil's North-East tip to the extreme South (...). This great coastal forest gave way in the hinterland to the "Catinga" in the North and the "Campos cerrados" in the South. It extended further South from Rio de Janeiro into the high mountain forests of the Serra do Mar (...). What remains of it is being cut down, either for agricultural purposes or to make charcoal (...) it still provides Brasil with some of its finest timber: *Dalbergia nigra, Aspidosperma peroba, Astronium fraxinifolium, Paratecoma peroba* (...) Bahia's forests supplied luxury woods: Pau brasil (*Caesalpinia echinata*), Pau violeta (*Dalbergia caerensis*) and Pau rosa (*Dalbergia frutescens*)."

This forest, although differing in species from that of the Amazon region (according to Ducke), nonetheless resembles it in terms of its range of botanical families: an abundance of Leguminosae, Sapotaceae, Lecythidacea and Lauraceae.

COLOMBIA

In 1975, Colombia's forests covered just over 46 million hectares, of which 35 million were in the Amazonian region, over 8.5 million were coastal forests and the rest mostly montane forests.

The forest belonging to the Amazonian block and isolated by the Andean cordillera, is similar to that of Brasil's Western hylaea and is only minimally exploited.

The coastal forests provide most of the country's exploitable forest resources: the Pacific coastal forest resources: then Pacific coastal forest then covered more than 5.6 million hectares, i.e. 12% of Colombia's forest area, and the Atlantic seaboard forest slightly less than 3 million hectares, 1.75 million of which were at the mouth of the Atrato and thus directly exploitable.

The extent of these coastal forests is likely to be far smaller today, as the deforestation rate since 1975 is estimated at 500 000 ha per year!

TABLE OF TYPICAL MOIST UPLAND FOREST SPECIES IN EIGHT REGIONS

Region	Species	Family
1. Amazon Delta	*Parkia* spp. *Vatairea guianensis*	Leguminosae
	Ormosia spp.	Leguminosae
	Manilkara spp. *Pradosia* spp.	Sapotaceae
	Erisma fiscum, Vochysia guianensis	Vochysiaceae
	Virola spp.	Myristicaceae
2. North-Eastern Amazon	*Micropholis* spp., *Ecclinusa* spp.	Sapotaceae
	Chrysophyllum spp. *Manilkara* spp.	Sapotaceae
	Epurua spp. *Swartzia* spp.	Leguminosae
	Ormosia spp. and *Inga* spp.	Leguminosae
	Goupia glabra	Celastraceae
	Iryanthera spp.	Myristicaceae
	Qualea spp.	Vochysiaceae
3. & 4. Regions around the Tocantis/Gurupi rivers and the Xingy/Tapajos rivers	*Swietenia macrophylla*	Meliaceae
	Cedrela odorata, Carapa guianensis	Meliaceae
	Vouacapoua americana	Leguminosae
	Piptadenia spp. & *Peltogyne* spp.	Leguminosae
	Cordia goeldiana	Boraginaceae
	Mezilaurus itauba	Lauraceae
	Astronium spp.	Anacardiaceae
	Jacaranda copaïa	Bignoniaceae
	Hevea brasiliensis	Euphorbiaceae

Region	Species	Family
5. Madeira and Purus rivers area	*Hymenolobium excelsum*	Leguminosae
	Peltogyne densiflora	Leguminosae
	Eperua spp.	Leguminosae
	Swietenia macrophylla	Meliaceae
	Carapa guianensis	Meliaceae
	Cordia goeldiana	Boraginaceae
	Manilkara huberi	Sapotaceae
	Theobroma spp.	Sterculiaceae
	Hevea brasiliensis	Euphorbiaceae
	Euterpe oleraceae	Palmaceae
6. Western Hylaea from the Jurua to the sub-Andean borderlands	*Theobroma* spp. and numerous *monocotyledons*	Sterculiaceae
		Myristicaceae
		Leguminosae
		Bombacaceae
		Lauracaceae
		Rubiaceae
		Musaceae
		Zingiberaceae
		Marantaceae
7. North-West Hylaea from the Rio Negro to the Trombetas	*Dimorphanda* spp.	Leguminosae
	Peltogyne spp.	Leguminosae
	Eperua spp.	
	Dicorynia spp.	Leguminosae
	Macrolobium spp.	Leguminosae
	Swartzia spp.	Leguminosae
	Carapa guianensis	Meliaceae
	Cedrela odorata	Meliaceae
	Cariniana micrantha	Lecythidaceae
8. Acre region	*Swietenia macrophylla*	Meliaceae
	Cedrela spp.	Meliaceae
	Torresea acreana	Leguminosae
	Hevea brasiliensis	Euphorbiaceae

These forests are essentially of the moist upland type, varying in composition according to altitude, and the lower-altitude forests near the coast have proved to be those most richly stocked with marketable species: *Brosimum utile*, *Virola* spp., *Terminalia* spp., *Bellucia grosularoides* ...

Apart from mangrove (300 000 ha), two particular plant formations deserve mention: the Guandal and the Catival which, like the Varzea of Brasil, are seasonal swamp forests containing valuable species.

The Guandal forest covers about 0.8 million hectares, i.e. 14% of the total Pacific coast forest. It is characterized by the presence of two exploitable species, the Cuangare (*Dialyanthera gracilipes*) and the Sajo (*Campnosperma panamensis*), which can constitute between 45 and 75% of the total population. This riparian seasonal swamp forest grows on very poor, undrained acid soils; it is heavily exploited and its survival is due only to the inaccessibility of some of the stands and its regenerative powers.

The Catival forest, which extends over about 400 000 ha in the Rio Aratro area, is characterized by the predominance of the Cativo (*Prioria copaïfera*), a highly sought-after timber species that can constitute up to 60% of the population, the rest of which also consists of valuable species: *Carapa guianensis* or *Virola* spp. It has been even more severely affected by over-exploitation than the Guandal, and is consequently endangered in spite of its natural regenerative capabilities.

ECUADOR

In 1980, 58% of Ecuador's total area was covered by natural tree formations: about 17 million hectares, almost 2 million of which were already destined for agricultural uses.

Approximately 5 million hectares, mostly located in the cordillera zone (sierra), were listed as playing a protection role. These were chiefly mountain formations, varying greatly in their characteristics according to soil, altitude, exposure and topography, the most typical being the moist forest found at altitudes of between 500 and 1 000 m with annual rainfall between 3 000 and 8 000 mm and featuring small, misshapen, moss-covered trees (a great variety of Lauraceae, *Nectandra* spp., etc.).

The majority of the productive forests are of the moist evergreen type and are located in the lowland plains (at altitudes below 500 m) along the coasts (Noroccidente) and in the Amazonian region (Oriente): these totalled 2.5 and 7.5 million hectares respectively in 1980.

Note: At that date forest plantations already amounted to around 53 000 hectares, mostly located in the central mountainous zone and consisting of Eucalyptus (particularly *E. globulus*), originally introduced in 1879, and also *Pinus radiata.*

The evergreen forest of the Oriente region is of the Amazonian type, similar to that of Colombia and Peru and of relatively low density and with a rather low exploitable volume of valuable species: 10 m^3/ha.

These thick forests are located chiefly on the Eastern llanos (plains), but are also found in the most secluded portions of the Yungas (sub-Andean region). In the Andean zone there remain only severely endangered forest relicts.

Depending on latitude and altitude, the formations can be dry, subtropical or tropical; as ecological conditions vary from South to North, the forest grows richer in species and more and more luxuriant, finally becoming identical to the Brazilian high forest of Acre Region and Rondonia.

In the Yungas the forests grow on steeply sloping soils, and on the llanos they occupy poor soils often subject to seasonal flooding.

Consequently, only 13.5 million of the existing 44 million hectares of forests can be considered accessible and suitable for development.

The most sought-after and heavily exploited species is the mara (*Swietenia macrophylla*), and in spite of the distance and inaccessibility of many stands, some forecasts estimate that the growing stock of this species is in serious danger of exhaustion within the next 15 years.

Note : the dry forests of the South are characterized by a useful species, the quebracho colorado (*Schinopsis balansae*).

III. FOREST POLICY, LEGISLATION AND ADMINISTRATION

Before examining the more technical aspects, such as those concerning forest resources and their management, we have sought to "establish" the political, legislative and administrative context by a fairly exhaustive but concise review of the various countries; this step appears necessary for a better understanding of the "field situation".

1. THE ISTHMUS COUNTRIES:

GUATEMALA, HONDURAS, EL SALVADOR, NICARAGUA, COSTA RICA AND PANAMA

These six countries have many common features in terms of forest policy, legislation and administration.

- The forest legislation is still all too recent, and in some countries, such as Guatemala, it has only just been finalized. In addition, it consists of purely restrictive laws on exploitation activities that do not thereby ensure forest protection. The laws establish numerous procedural hurdles to be overcome in order to obtain exploitation licenses, but do not contemplate the need for this resource to be developed in the most advantageous manner, with consequent management of forests with a view to sustained production.

- The forestry departments, however great their enthusiasm, are faced with the problems of insufficient means, in terms of both human resources and equipment, to ensure compliance with the law and to promote rational measures for the management of this resource. The technical sections responsible for carrying out fieldwork such as forest inventories are either non-existent or are reduced to an absolute minimum.

  The situation in each country is summarized below.

- COSTA RICA: Forest resources come under the authority of the Ministry of Natural Resources, Energy and Mines through the Forests Department (DGF), which was established in 1969. The first forest law was passed in 1969 to control the use of forests and develop the private timber plantations (through tax benefits).

  The DGF is at present attempting to reconcile the interests of private enterprises and Government by simplifying administrative procedures. Another department of the same Ministry is responsible for the protected areas.

- EL SALVADOR: Wood resources are controlled by the National Centre for Natural Resources (CENREN), an agency of the Ministry of Agriculture. The 1973 forest law has nonetheless proved inapplicable to date.

- GUATEMALA: The Forests Department (DIGEBOS) of the Ministry of Agriculture and Animal Husbandry was set up in 1988, but the Forest Law enabling this Department to perform its functions, above all with regard to the

development of timber plantations, was not passed until November 1989. It liaises with CONAMA on environmental issues.

- HONDURAS: CODHEFOR (Corporación Hondureña de Desarollo Forestal) was established by executive decree in January 1974 and is responsible, on the basis of the Forestry Law of 1961, for the management of both private and public forests. CODHEFOR thus has ample powers to draw up and ensure the implementation of whatever forest management measures it considers most advantageous for protection, development, exploitation and industrial development with reference to forests and forest produce.

- NICARAGUA: The first forest law dates back to 1905 and concerns forest protection. In 1979 IRENA (Instituto Nicaragüense de Recursos Naturales y del Ambiente) was established to formulate and implement the national policy on natural resources and the environment. It is thus responsible for the planning, administration, supervision, study, management (including reforestation) and development of the natural resources that are exclusively State-owned. In theory, no tree can be felled without prior authorisation from IRENA.

  A parallel body, CORFOP (Corporación Forestal del Pueblo), was also established in August 1979. It is a State agency responsible for operating the wood processing units (sawing, peeling, etc.) and marketing wood products (as the sole agency authorised to export them). Exploitation permits are, after consultation, issued by IRENA to CORFOP which is responsible for extracting forest produce and distributing it to the various processing units.

- PANAMA: INRENARE (Instituto Nacional de Recursos Naturales Renovables), an agency of the Ministry of Agriculture and Animal Husbandry, was established in 1986 with broad powers in the forest resources field. The most noteworthy point is that, due to the country's severe deforestation, it was decided by decree in April 1987 to ban all tree-felling throughout the country for a period of five years.

In spite of these forest laws and administrations, there is not a single forest management plan for sustained production in Central America, save for felling management plans, particularly those of Costa Rica.

This lack of interest in sustained forest management is, as in most tropical countries, the result of financial difficulties that prevent long-term investments.

MEXICO

Mexico is not a traditionally forest-minded country, and it was not until 1940 that the concept of forest protection and forest "culture" first began to take shape.

Mexican society presently adopts various attitudes with regard to the forest ecosystem, depending on the social strata involved:

- a conservationist or even ecologistic stance originating in urban milieux;
- the productivity-oriented approach of the private sector enterprises, favouring land-use conversion witha view to maximum economic returns;
- and a mistrustful attitude on the part of the peasantry, who wish to use the forest for their immediate needs or in accordance with traditional practices.

On their part, the governmental authorities seek to reconcile these divergent interests without actually changing their chiefly protection-oriented policy (even though this policy has not proved effective). The role of the country's forest services has in fact been restricted largely to the State-owned forests.

The object of the 1926 Forest Law was to conserve, restore and monitor the forest vegetation, and to train and organize the necessary technical personnel. Two new laws were enacted in 1943 and 1948 which were again wholly conservationist as far as the State-owned forests were concerned but otherwise gave private enterprise a clear field. This situation remained virtually unchanged until the 1987 law on ecological balance and the protection of the environment. The principal agencies and departments operating in the forestry field are under the authority of the Comisión Nacional Forestal.

BELIZE

In Belize the current legislation is incapable of safeguarding the continued existence of forest reserves in the face of agricultural encroachment.

The forest policy was formulated in 1954, but no policy was defined with regard to land occupation or reserve protection.

The present procedures with regard to transfer of ownership and reservation status are poorly formulated and extremely arbitrary.

The production policy (forest exploitation) is very vaguely defined: "to increase the production of forest reserves by assuring full utilization of hardwoods and pines and encouraging the use of secondary hardwood species and other forest produce".

The origin of certain difficulties can in fact be ascribed to several factors:

- on the one hand, the decisional spheres of the Minister and the Head of the Forestry Department are poorly defined;
- on the other, logging permit rights and obligations are not clearly specified;

- lastly, there is room for improvement in the procedures for classifying and declassifying State forests and the wording of the regulations concerning charges and penalties.

The Forestry Service of Belize (formerly British Honduras) was created in 1922, but its present activities are curtailed by the usual difficulties (scarcity of personnel, scarcity of funds: there is not even an itemized forestry budget) which have resulted in a dramatic lack of control over exploitation and logging permits (concessions), and information and education of the local population on forest issues. The exploitation charges and control system is particularly inadequate:

- little distinction is made between species of very different value;
- no differences are foreseen in relation to diameter;
- there is no list of exploitable species or exploitable diameters (established on a rational basis).

To this we may add that the productive forests are now privately owned to a very large extent.

2. THE CARIBBEAN ARCHIPELAGO COUNTRIES

The situations encountered vary enormously, ranging from the total absence of any forest policy (and even any forests) to the formulation of sophisticated management plans (Trinidad) implemented by a well-established forestry administration, as will be described further on.

The case of Puerto Rico is instructive from the "forestry issues" standpoint. In fact the forest-consciousness of this island is characterized by two phenomena:

- The importance of soil conservation problems, linked to the catastrophic erosion suffered by the island in the 1930s.

- Nature preservation-consciousness due to the fairly high standard of living, the importance of the tourist industry and the biological richness linked to insularity.

The scientific authorities estimate that 445 000 ha must be kept under forest, i.e. all gradients exceeding 40% and the catchment areas of springs and reservoirs.

In addition, the very high proportion of endemic species of both fauna and flora, due to insularity, has led the authorities to classify the last virgin forests and refuges of endangered species as reserves.

Fourteen forests of all types, covering a total area of 34 000 ha, are thus preserved in the framework of the Commonwealth Forest System.

The productive forests suffer from an image that brands them as abandoned wastes of no economic interest. Recent inventories have, on the contrary, shown that the volume of standing timber is far from negligible and that simple techniques could improve its quality.

3. THE GUYANESE REGION COUNTRIES

SURINAME

Since 1947 the national forests have been entrusted to Suriname's Forestry Service with a view to:

> "managing the country's forests through inventories, research, the inspection and supervision of forestry activities and the exportation of wood" so that they will perpetually produce the greatest possible benefits for the community.

This remains the Government's official policy.

In 1970 a government report stressed the importance of reforestation and conservation of the natural environment. But the means deployed were not able to satisfy its needs and the Forestry Service, realizing the inadequacies of the government policy, developed its own approach based on five main points:

- Inventory of new areas as the coastal plain is overexploited;
- Reforestation of the overexploited areas, chiefly with *Pinus caribaea hondurensis*;
- Forestry research, above all on reforestation;
- Establishment and training of forestry personnel;
- Launching of forest development projects with the assistance of the Netherlands.

The aim was to use the plantations to satisfy local needs and to obtain high-quality timber for export from the natural forests. However, by the end of the 1970s it had become obvious that the plantations were a failure, and this led to a renewed interest in natural forest silviculture.

Legislation

The Forestry Service is an independent organization belonging to the Ministry of Natural Resources. Its activities are governed by three basic statutes:

- the Woods Statute (1947),
- the Special Concessions Statute (1947),
- the Timber Inspection Statute (1950)

The latter governs inspection by the Forestry Service of all logs, timber and wood products with the exception of plywood and particle-boards.

The statute on special concessions was enacted in 1947 for the benefit of BWC (the Bruynzeel Wood Company), granting them a 500 000 concession area for 25 years.

The Woods Statute still regulates the harvesting of forest produce on State lands through the granting of concessions and logging permits, the establishment of charge rates and the inspection of logging operations by the Forestry Service.

In practice, during the last 40 years there have been five major types of land-use in relation to forest management:

- ordinary concessions	1 800 000 ha
- managed concessions	260 000 ha
- forests with logging permits	588 000 ha
- plantations	6 900 ha
- natural reserves and national parks	572 000 ha
- forest reserves	492 000 ha

The ordinary concessions have a maximum duration of ten years and a maximum area of 50 000 ha. The extension of felling rights must be applied for each year, but as a rule it is always granted if exploitation is being conducted in compliance with the regulations.

The managed concessions were inventoried between 1949 and 1959 by the Forest Service, which drew up a management plan specifying:

- topographic characteristics;
- forest characteristics;
- inventory of commercial timber volumes;
- compartmentation based on natural boundaries (200 to 300 ha per compartment) to rationalize the harvesting system.

The logging permits are granted to communities of American Indians or black refugees for an indefinite period, as a means of improving living conditions and providing employment.

The logging royalties remained very low until 1981. They have been increased to US$ 4.00 per m^3 for valuable species and US$ 1.4 for secondary species. There is also a tax on haulage on public roads.

Political factors

In theory, all forests belong to the State and are controlled by the Forestry Service. Given the low population density, land access is not subject to social constraints, but political factors nonetheless play an important role.

In the first place, the granting of concessions is subject to political influence, which also affects the application of the penalties prescribed by the law, resulting in the rapid skimming-off of the forests' most valuable assets and blocking the establishment of real logging-processing concerns.

Secondly, BSH occupies a privileged position. In 1972 an agreement was signed that renewed BSH's concession and established a financial link up with the Government. Since then BSH blocked all attempts to reform the legislation governing the concessions so as to introduce the concepts of sustained productivity and multiple-use forestry. Then in 1982 BSH became a State-owned company.

Lastly, Dutch aid is important. It funds heavy investments, but only on a short-term basis through specific projects.

In addition, since 1985 guerilla warfare has fostered insecurity, which is never favourable to forest management.

Forest administration

An embryonic forestry department operated from 1904 to 1925, but after a promising beginning it was suppressed due to the country's economic difficulties and its lack of financial autonomy.

The demand for timber after the Second World War justified the establishment of the Forestry Service, which won a reputation for competence and efficiency but does not have sufficient legal ammunition for its tasks.

The Service is attached to the Ministry of Natural Resources. It is headed by a Conservator and consists of eight divisions:

- Central administration,
- Planning and research
- Forest inspection
- Wood and timber inspection
- Wildlife and reserves management
- Reforestation
- Forest engineering
- Training.

All these divisions are based in Paramaribo, but there are over 50 forest stations operating in the field.

The Forest Service operated efficiently, with adequate financial and human resources, until 1978. But the relative failure of the plantation schemes, and above all the spreading guerilla warfare and economic difficulties have greatly reduced its activities.

FRENCH GUIANA

The French Department of Guyana is very much of an exception in the context of continental South America, given its tiny population (100 000 inhabitants) with a nearly European standard of living and social security, ensconced in a vast territory almost entirely covered with almost unthreatened moist forest (over 8 million hectares).

Nonetheless, French Guiana does reveal some significant weaknesses. We note in particular the smallness of its market, confined to its sparse population; the limited development of its agricultural and industrial sectors, and a still embryonic road network.

Forest administration functions in Guyana come under the Department of Agriculture and Forests in the case of public service duties, and the National Forests Office (Guyana Regional Division) for everything concerning the management and equipment of the State-owned forests (which total 7.5 million hectares, in other words almost all the wooded area of the country).

Following Decree No. 86-1169 of 31 October 1986, the sphere of competence of the Director of Agriculture and Forests has been augmented in the forest sector by the following public service functions:

- the safeguarding of woodlands,
- the preparation of regional forest policy,
- the preparation of the State's annual forest investments plan,
- the implementation of public intervention measures,
- the promotion and follow-up of wood industry enterprises (primary processing sector).

Note: It should be noted that private forest ownership is virtually non-existent in French Guiana.

The National Forests Office (ONF) is responsible for the performance of the above functions on the behalf and subject to the authority of the Director of Agriculture and Forests.

The principal functions carried out by the ONF are derived from the application of the Forests Code and the State Property Code. They cover:

- the management and equipment of the State-owned forests,
- the granting of exploration and harvesting permits and exploitation licences, and private sale agreements per product unit.

Other functions are performed on the basis of agreements on a national or local scale entered into with various partners, such as:

- the execution of annual forest access road building programmes,
- the management of the Guyanese Space Centre's forest lands, amounting to 48 500 ha.

The means available to the ONF, particularly as regards human resources, are relatively small in relation to the extent of its functions.

4. THE AMAZONIAN COUNTRIES

BRAZIL

Public bodies: it must be noted, first of all, that in Brazil the public agencies active in the forests and forestry sphere are of two types: national (federal) organizations operating throughout the entire country, and State bodies whose activity is confined to a single State.

The role of the State bodies, which it would be tiresome to list in detail, is to take over from the national agencies at a local level, taking into consideration the local context and the specific characteristics of their forests, industries and wood sector in general.

The following national (federal) agencies deserve mention:

- IBAMA (Instituto do Meio Ambiente et dos Recursos Naturais Renovaveis). This institution, which amalgamates the previously separate agencies IBDF, SEMA, SUDEPE and SUDHEVEA, respectively dealing with forests/natural parks, the environment, aquaculture and fisheries, and rubber, was officially established in August 1989 and is still in the throes of administrative and technical reorganization. It appears that environmental issues will play an important role in IBAMA.

  Its general mandate is to establish the country's environmental policy and the management of its natural resources. Its more specific role in the forestry field is described further on with regard to forest management, inventories etc.

- EMBRAPA (Empresa Brasileira de Pesquisas Agropecuarias), created in 1972 for the development of agronomic and animal husbandry research; it has included a forestry research programme since 1977.

- CEPLAC (Commisao Executora do Plano da Lavoura Cacaueira) operates in the forestry field by the introduction of mixed plantations of cocoa in association with various tree species.

- IBGE (Instituto Brasileiro de Geographia e Estatica) which was responsible, amongst other things, for the phytogeographic classifications quoted in previous chapters.

Several other institutes and agencies engaged in research and development activities primarily concerning the humid tropics should also be mentioned:

- CPATU (Centro de Pequisas Agropecuario do Tropico Humido) - Research Centre.

- SUDAM (Superintendencia do Desenvolvimiento da Amazonia) - Development agency.

- INPA (Instituto National de Pesquisas da Amazonia) - Research Institute.

- and EMBRAPA (already mentioned).

This far from exhaustive list gives a fairly clear idea of the complexity existing in the distribution of functions and responsibilities, although there is no reason to doubt the good work done by most of these organizations.

Forest policy and administration: management of natural forest and timber plantations is foreseen in the Forest Code (Law No. 4771 of September 1965). This legislation was strengthened in July 1986 (Law No. 7511) by the establishment of long-term management programmes for all forests subject to exploitation.

Prior to all exploitation operations, the preliminary management plans must be submitted to IBAMA for agreement, amendment and further verification and, in theory, constitute a "sine qua non"

However, these procedures have little impact in practice. For instance, in the State of Rondonia (Cf. T. Balaguer Quilez, 1989) the private sector took advantage of the regulations to legalize the origin of logs extracted from different sites by means of annual felling in the managed area... Wood from reserved areas can thus be marketed with impunity.

In addition, IBAMA does not have a large enough organization to study and approve all the various management plans, and above all, it lacks the field organization necessary for effective supervision of the execution of the works.

All in all, in the State of Rondonia only the National Parks and Reserves and one State Forest have management plans.

This situation is not unique to Rondonia, and with a few variations is found throughout legal Amazonia.

The forest policy as a whole has (since 1988) been to zone the territory, bearing in mind the fact that over nine-tenths of the Amazon basin soils are of low fertility, and in most cases unsuitable for agriculture.

About 45% can be cultivated on the condition that refertilizing inputs are applied. The rest must imperatively be kept in their wooded state, their valorization being assured by forest management in the areas where socio-economic conditions are favourable.

For example, the creation and maintenance of a series of forest reserves (under a management plan) is foreseen over an area of about 50 million hectares around the Carajas industrial complex.

This policy, which seeks to combat the dramatic problem of deforestation, is consistent with the national programme launched in 1988: PROGRAMA NOSSA NATUREZA.

COLOMBIA

The forest sector is totally in the hands of private enterprises, on which INDERENA (Instituto Nacional de los Recursos Naturales Renovables y del Ambiente), the agency responsible for implementing forest policy, can have only a minimal impact for lack

of both means and authority. Proof of this situation is provided in the final document of the UNDP-FAO-INDERENA Project of 1981, which reports the destruction of portions of the project's research installations by logging companies and the local population.

Moreover, the operative capabilities of organizations such as CONIF (Corporacion Nacional de Investigacion y Fomento Forestal), responsible for forest research and development, are very limited. The training of foresters is also neglected, and is merely an individual specialization for university-trained agronomists.

The goal of the present Forestry Action Plan for Colombia (PAFC), drawn up by the National Planning Department (DNP) is to ensure better integration of the forest sector in the national economy through various quantifiable outputs and also as a support for rural development.

Colombia's forest problem can be summarized in the five major points identified by the PAFC:

- Very low contribution of forest activities to the GNP.

- Severe imbalance in regional development levels, to the detriment of forest areas;

- Many symptoms of disorderly exploitation: erosion, badly regulated water resources;

- Irrational management of resources due to dispersion, obsolete processing structures and an underdeveloped, inadequately known market for forest products.

- Lack of government action at the institutional level and in support of the private sector, which consequently lacks interest in wood sector industries.

To overcome these problems, action must "start from scratch" in the technical sphere:

- strengthening of institutional measures with a view to more effective resource management, including in particular a review of the legislation and the training and recycling of operational personnel.

- the establishment of territorial plans for major catchment areas with due regard for regional identities;

- development of forest product utilization; and

- promotion of research on all aspects of the wood sector.

ECUADOR

Ecuador's forest policy is governed by the "Ordenanzas Forestales" (Forest Laws and Decrees), but the Forestry Service, an agency of the Forest Development Department of the Ministry of Agriculture and Animal Husbandry, has only a slight impact, proportionate to the means allocated to it (an FAO project strengthened the Forestry Service in 1977).

Most forest development projects are implemented in the framework of specific Regional Programmes comprised in the National Development Plan, either with international aid or with domestic funding, for instance through FONAPRE (Fondo Nacional de Pre-Inversión).

Numerous agencies are active in the forestry field, including both semi-governmental bodies such as CREA (Centro de Reconversión Económica del Azuay, Canar y Morona Santiago) and PREDESUR (Programa para el desarrollo regional del Sur) and private organizations: EMDEFOR (Empresa mixta de Desarrollo Forestal).

The wood-processing industries, which are faced with wood supply problems, have also decided to prepare for the future by opting for reforestation in preference to natural forest management (which has proved conflictual with agriculture).

The NGOs (Non-Governmental Organizations) are also very active. For example, in 1987 Fundacion Natura signed an agreement with the Governments' Monetary Council that authorized it to exchange a maximum sum of 10 million US dollars against local currency bonds (nature-debts exchange system); the funds are to finance nature conservation activities.

PERU

Peru's agricultural policy is based on the concept of the "green revolution", i.e. self-sufficiency through the development of a modern agricultural system using genetically improved staple species (rice, maize, soya, ...) and plentiful inputs. Export crops (coffee, cotton, cocoa, ...) provide the hard currency necessary to purchase these inputs.

In this framework, the Amazonian forest is considered a potential "El Dorado". It is viewed in the first place as a reserve of land for internal migration from the Andes, and as a reserve of wood to be "mined" to supply timber for the wood-processing industries and the urban market.

The resulting forest legislation is analysed below; but with the failure of the agricultural policy and the increasingly evident ecological problems, a new interest in studying and following traditional forest utilization techniques, particularly with regard to food production, is now coming to the fore.

The Forest Law of 1975 (Ley Forestal y de Fauna Silvestre) defines the terms of reference for forest management in Peru, and in particular makes it clear that flora and fauna resources are national property and that no acquired rights can be claimed over them.

This latter concept was ratified in 1979 and extended to all natural resources, renewable or otherwise.

In reality the current legislation is endowed with sufficient technical, ecological and administrative content to permit sustainable utilization of the resource, but it is certain that, for want of adequate means and determination on the Government's part: "The application of the legislation has been reduced to a minimum, to approximately 40% of its articles" (Cf. Report No. 17 - FAO - 1989)

According to this legislation, forests are classed in the following different categories:

- national forests: Bosques Nacionales,
- "usable" forests: Bosques de Libre Disponibilidad,
- protection forests: Bosques de Protección
- conservation forests: Unidades de Conservación
- private forests,
- plantation forests.

Apart from the protection forests and conservation units the other forests maybe used for commercial and/or industrial purposes, under contracts or permits issued by the Ministry of Agriculture.

Private intervention is regulated by the 1980 Law (Ley de Promoción y Desarrollo Agrario) which supplemented the previous legislation by foreseeing the possibility, on an exceptional basis, of private valorization in National Forests.

Exploitation permits are granted at three levels: national, by the Ministry of Agriculture; regional, by the Director of the District Agrarian Unit, and local, by the Forest Units. A series of model contracts are foreseen according to the legal status of the forest, the extent of the permit and its duration, and the investments proposed.

Note: The most easily obtained logging permits, and the least exacting for their beneficiaries, are those issued for areas of less than 1 000 hectares (to encourage and help small-scale enterprises, but with obvious possibility of abuse).

The Dirección General Forestal y de Fauna of the Ministry of Agriculture is also responsible for the approval and control of forest management and reforestation studies.

A reforestation tax, the "Canon de Reforestación", has been levied since 1980 on forest logging concerns to fund tree-planting campaigns (conducted in principle by reforestation committees).

The implementation of the management plans submitted in order to obtain exploitation licenses has remained "theoretical", because these plans are based on silvicultural concepts that lack any concrete experimental backing; and this, combined with the lack of interest or motivation on the part of these concerns, reduces these forestry management studies and proposals to the status of mere bureaucratic formalities.

The result is that the legislation, although plentiful, lacks concrete application; even the plantation forests are not subject to management programmes or even simple silviculture monitoring, due to a vacuum that is not only technical but legislative as well.

A pragmatic economic approach favouring private investments could be one of the options to make forest management a reality, but these cannot be easily anticipated in a precarious socio-economic context.

The Plan Nacional de Acción Forestal (1988-2000) aims to to resolve this situation, but difficulties have been encountered in reconciling national priorities with those of international donors, which translate into a conflict between productivity and forest conservation.

BOLIVIA

According to the General Forest Law, all natural forests belong to the State, whoever the owner of the land may be; moreover, the notion of land tenure is confused and imprecise... often there is no documentary proof of ownership.

By law, there are ten forest reserves, consisting either of classified forests (in which only logging is permitted) or reserved forests (where no operations whatsoever are allowed ... the forests are "frozen"), but unfortunately their boundaries are vague and their delimitation is inadequate. They cover approximately nine million hectares, but some portions have been destroyed as a result of spontaneous or legal land settlement.

The chief agencies operating in the forestry and wood sectors are:

CDF : Centro de Desarrollo Forestal
CNF : Cámara Nacional Forestal
CORDES : Corporación Regional de Desarrollo
Civic committees (at provincial level).

The CDF receives from the declared forest enterprises the payment of forest royalties (for logging) charged per m^3 of rough timber trucked (from 1 to 6 US dollars according to species); these royalties are paid into a national forest fund.

The equivalent of half the above sums is paid by the logger as a contribution to the PPF (Forest Plantations Programme) which, under the control of the CNF, conducts experimental timber plantation and agro-forestry projects.

Lastly, since 1982 the CORDES have been receiving 11% of the lump-sum production cost per m^3 of sawnwood (about 0.22 US dollars), which is in fact established by agreement between the CDF and the CNF, to finance works of public and communal utility (as a rule in the region where the wood was produced).

Two hundred exploitation permits or concessions are in force for individual areas of 10 000 to 20 000 hectares (totalling 32.500 million hectares) located chiefly in the main classified forests such as Los Chimanes, Guaravos and El Chore. In the last two, it is estimated that about one million hectares have been deforested ....

VENEZUELA

Venezuela's forest policy, implemented by the Ministry of the Environment: MARNR (Ministero del Ambiente y de los Recursos Naturales Renovables) is based on the Land Management Plan (Plan de Ordenación del Territorio) in accordance with two laws: the Ley Orgánica del Ambiente and the Ley Orgánica de Ordenación del Territorio, and with the current National Plan (VII Plan de la Nación).

This policy is founded on three principles: sustained production, protection and multiple use of forest ecosystems. Its objectives are: to integrate wooded areas in the development of the country (job creation, self-sufficiency in wood and derivatives, etc. ...), to maintain their productivity and/or their environmental protection role, and to defend them from the destructive action of man.

As regards the last objective, the preceding description of the phenomenon of intensive deforestation clearly reveals that it is far from having been achieved for lack of decisiveness and political support "high up" as regards MARNR.

As they do not really have the means to cope with the socio-economic problem of deforestation, this Ministry's departments have concentrated their efforts on three aspects:

- Information and research
- Determination of forest resources
- Rational management of the resource (planning)

For example, as foreseen by the Forest Law (Ley Forestal de Suelos y de Aguas) MARNR is responsible for regulating the utilization of forest resources; hence, with its guidance, long-term logging operations subject to a management plan have been progressively encouraged: in 1980 virtually all rough timber production (80 to 90%) was under annual licenses, but by 1987 a large proportion (40%) of this production was under long-term concessions.

MARNR controls the "Areas bajo régimen de administración especial", i.e. the productive forests, protection forests and national parks.

The productive forests consist essentially of ten Forest Reserves totalling 11.3 million hectares.

The protection forests amount to about 14 million hectares, the National Parks cover 7 million hectares, and public and private managed reforestation areas total 300 000 ha (this last figure is of some importance).

The administrative organization of the services headed by MARNR (established in 1977) is highly structured: watershed and national park management is handled by two separate agencies, whilst productive forests and woodlands are the responsibility of the Venezuelan Forestry Service (SEFORVEN, created in June 1989).

This forest administration is well designed and structured, but (once again), it finds it difficult to operate effectively in the field (human resources, equipment and funding are all distinctly inadequate).

5. RECAPITULATION

Isthmus countries and Mexico

The forest laws are recent, having only been introduced in the 1970s. They are currently being revised or even totally replaced by new legislation (Guatemala) with a view to promoting forestry activities.

Generally speaking, these laws establish regulations for the utilization of forest resources and their protection. The trend is towards rational and continuous forest use, with management plans a requirement. In some cases, the new laws go as far as limiting or even prohibiting forest exploitation (Nicaragua).

The agency responsible for forests is usually a department of the Ministry of Agriculture (El Salvador, Guatemala, Nicaragua, Panama), or occasionally of the Ministry of Natural Resources and Mines (Costa Rica). Honduras is the only country that possesses a National Office in charge of forests.

The problems encountered by the forest administration are many, and do not differ greatly from one country to another: insufficient and inadequately qualified personnel, and inadequate resources. Sometimes there is no forest management service at all; and in many cases the laws are not applied due to the pressures exerted on the administration by logging concerns.

Countries with low population pressure

In Suriname, the forest policy dates back to 1947 and is to "manage the country's forests so that they eternally produce the maximum benefits for the community through inventories, research, inspection and supervision of forestry operations and timber exploitation".

The forestry service, which comes under the Ministry of Natural Resources, is responsible for the application of the law in the national forests. All the country's forests are national forests.

The first legislation dating from 1947 served chiefly to establish the conditions for exploiting the forest, which is extremely extensive and subject to very little human pressure. They regulate the issuing of concessions and the amount of royalties, which are low (around US$1/m^3). In 1947 a vast concession (500 000 ha) was granted to Bruynzeel Company (BSH).

In the 1970s, the emphasis was on conservation and reforestation measures, with Dutch bilateral cooperation. At the same time, the forestry service proposed a new legislative approach that would take into account the sustained character of production and multiple forest uses.

These proposals came up against the political constraints that weigh upon forestry in this country. The granting of concessions is determined by non-technical criteria; the BSH company blocked any revision of timber royalties until it became a State company in 1982; the waning of support from the Netherlands and the outbreak of guerilla warfare also weighed very heavily on this status quo.

The forestry service, which was well structured and endowed up to the beginning of the 1980s, is losing ground at present.

In French Guiana, most of the forested area is French State property. It is consequently administered by the National Forests Office. The exploitation policy for this resource is based on concessions granted for specific areas and durations to loggers who must also operate wood processing plants. This rule aims to foster the development of local wood sector enterprises to meet sawnwood needs.

The administration responsible for the development of this sector is well structured but shortstaffed.

Brazil

In Brazilian Amazonia the problems of forest policy in South America are dramatically apparent.

The status and utilization of forests are governed by the 1965 Forest Code, which indicates in article 15 the need for "sustained forest management". This Code was augmented in 1984-85 by a series of regulations that make it obligatory, in particular, to plant a certain number of trees per m^3 felled. But the future of the forest depends first of all on a policy of land zoning, and secondly, on the organization of agricultural colonization.

An initial subdivision into "economic-ecological" zones revealed that 19% of soils are seasonally flooded (cultivation area), 46% ar poor but can be cultivated with inputs, and 30% are poor and unsuitable for cultivation. This last zone is to become a managed forest reserve. In the absence of zoning legislation, zones that should be left wooded are being cleared in controlled fashion; this situation is aggravated by an agricultural policy that gives rise to the opening up of roads following ill-conceived routes, and to speculation in land.

The Programma Nossa Natureza (Our Nature Programme - a land use plan based on suitability criteria), formulated in 1988, must be urgently applied to allow the establishment of a real forest policy (particularly in the Carajas region).

The Andean Countries

These countries all possess recent forest laws and the administrative structures necessary for their application. But present budget difficulties and social unrest push forest problems into the background in terms of government priorities.

More specifically, in the case of Venezuela, the present forest policy is detailed and well-conceived. It is formulated by the Ministry of the Environment and Renewable Natural Resources, which draws up a National Forestry Development Plan based on three principles: sustained yield in production zones, localised areas of total protection, and multiple-use forest management.

The objectives could serve as reference points for reflection: to integrate forests in regional development planning; to protect forests from the destructive action of man and natural agents; to ensure the rational utilisation of forests with a view to sustained production; to preserve the value of forests as protectors of other natural resources; to limit wood imports and provide exports; to increase forests' participation in national development.

The scarcity of funds is at present the chief obstacle to its implementation.

IV. STATE OF THE RESOURCE: INVENTORIES AND DEFORESTATION

To put it briefly, the salient features of the majority of tropical forests in general, and of those of Latin America in particular, are:

- insufficient knowledge of the resource (exploitation and development potential);
- the dual phenomenon of intensive deforestation and/or degradation of the forest ecosystem.

Forest degradation is a difficult phenomenon to quantify, as it involves modifications of the forest's ecosystem of detriment to its tree population, fauna or site (terrain, soil, microclimate ...) and which impair its potential by decreasing its production capability.

Deforestation is due to the conversion of woodlands to other uses, or reduction of the land's vertical cover to less than 10% (FAO, Unasylva, 1991).

The provisional data presently available from the FAO Forest Resources Evaluation Project (commenced in 1990 and scheduled for completion in mid-1992) are summarized in the following table.

PROVISIONAL ESTIMATES OF FOREST COVER AND DEFORESTATION IN 62 TROPICAL COUNTRIES

Continent	Number of countries examined	Total area	Forested area in 1980 (in thousand of ha)	Forested area in 1990	Deforestation per year	Trend 1981-1990 (% year)
Africa	15	609 800	289 700	241 800	4 800	- 1.7
Latin America	32	1 263 600	825 900	753 000	7 300	- 0.9
Asia	15	891 100	334 500	287 500	4 700	- 1.4
TOTAL	62	2 764 500	1 450 100	1 282 300	16 800	- 1.2

Note: The countries examined include practically all the moist forest zone and some dry zones as well. The figures are indicative, and must not be taken as regional averages.

These provisional and partial figures are sufficient in themselves to give an idea of the magnitude of the phenomenon of deforestation in the tropics, where a highly significant correlation has been noted between the forest cover trend and demographic estimates.

Not only does deforestation appear to be gaining speed in the humid tropics as a whole, but in addition the degradation of the biomass seems to be linked to the magnitude of the index of fragmentation (borders between forest and non-wooded land in relation to total forested area); in other words, "the more fragmented the forest, the greater its susceptibility to degradation" (FAO, Unasylva, 1991).

These two aspects, deforestation and degradation, are more specifically linked in the Central American Isthmus countries; we have decided for this reason to discuss them first and in some detail.

1. THE ISTHMUS COUNTRIES: COSTA RICA - SALVADOR - GUATEMALA - HONDURAS - NICARAGUA - PANAMA

On the whole the six Isthmus countries have similar morphological characteristics, which can be summarized as follows:

- A narrow Pacific coast, deforested since the last few decades, where only islands of broadleaved forest survive, exploited on an irregular basis to supply logs to small sawmills.

The land, with its generally rich soils, is used for agriculture and agro-industry. There are large plantations of cotton and sugar-cane, and also, but to a lesser extent, of bananas, coffee and cocoa on the lower slopes.

- A volcanic central zone with very abrupt contours, and altitudes of from 800 to 3 500 m. Here, although the land is better suited to forests than to farming, population pressure has given rise to intensive and uncontrolled deforestation to make way for shifting cultivation.

This is the zone where coniferous forests are to be found, made up of species such as *Pinus oocarpa* and *Pinus pseudostrobus*, to mention only the most intensively exploited varieties.

- Lastly, the vast low-altitude Atlantic zone, with low population density and few roads penetrating into the interior; this is where the reserves of broad-leaved tropical timber species are located.

The climate, which is always of the moist tropical type, varies according to exposure to Atlantic or Pacific ocean influences and above all to altitude. Rainfall thus ranges from 1 000 to 6 000 mm per year, and mean temperatures, which are around 30°C at sea-level, can be as low as 12°C above 2 500 m.

The density of population, which is as low as 23 inhabitants per km^2 in Nicaragua, rises to over 230 in El Salvador. The average for the six countries' total area of 508 894 km^2 is 52 inhabitants/km^2, with an overall population of 26 million. The rural population is always relatively large (43 to 67% of the total population).

The GDP per inhabitant varies from US$ 481 (Panama) to US$ 1 126 (Guatemala), but the agricultural economies are comparable:

- Export crops (coffee, cotton, sugar, bananas) are given priority.

- From the land-use standpoint the major agricultural holdings, which are export-oriented, are in sharp contrast to the peasant holdings, which practice fairly extensive subsistence farming.

- The rising population (2.8% per year) thus gives rise to large-scale clearance of forest areas (400 000 ha per year for the region as a whole) which, given the nature of the terrain, causes very serious soil conservation problems.

Knowledge of forest resources is very incomplete. For instance:

- in Guatemala the last forest cover estimate dates back to 1979, and there has never been a proper inventory;

- in Honduras, a COHDEFOR/ACDI project in the early 1980s compiled an estimate of available forest stock based on earlier inventories; in principle, a COHDEFOR forest inventory unit is supposed to continue and update this work;

- in Nicaragua, after the FAO inventory conducted from 1965 to 1973 in several Atlantic regions, an evaluation of forest resources for the country as a whole was carried out from 1981 to 1983 with Swedish cooperation support, with a view to establishing a Development Plan for the wood sector as a whole;

- in Costa Rica, El Salvador and Panama no recent estimate is available.

Hence it can be postulated that with the annual deforestation rate of 3 to 4% recorded in all the Isthmus countries, only about ten million hectares of actual forest can be counted upon: perhaps less than a million in Costa Rica; in El Salvador true forest can be said to be virtually non-existent, as what remains is mostly degraded forest used as cover for coffee plantations; Nicaragua, Honduras, Panama and Guatemala should each have 2 to 2.5 million hectares of forest (broad-leaved and coniferous).

Given this situation, it must be noted that reforestation only amounts to around 8 000 hectares per year for the whole region.

Efforts have nonetheless been made over the last twenty years to establish protected forest zones in the form of forest reserves, national parks or biosphere reserves. These protected areas have increased from about 30 in 1968 to over 240 today, equivalent to 9% of the total area of these six countries and approximately 25% of the natural forest ecosystems.

The principal countries that have adopted this protection policy are Costa Rica and Panama, which have given protected status to a considerable part of their national territory:

- 26% of Costa Rica, i.e. about 1.3 million hectares,
- 19% of Panama, i.e. about 1.4 million hectares,
- and 9% of the 6 countries as a whole, i.e. around 4.5 million hectares.

However, protected areas must not be confused with surviving forests; for instance, the Masaya Volcano National Park is not a woodland area.

Land use and its incidence on forest: in this Isthmus region there is a very sharp difference between the Pacific coastal zones, the "mesetas" and central cordilleras, and the Atlantic coastal zones, for both climatic and pedological reasons.

The Atlantic zones are by far the least densely populated and (still) the most heavily wooded; the best regions for agriculture are those of the Pacific coast and the Centre, which have deep volcanic soils... that are extremely fertile (under a milder climate).

This imbalance in population distribution linked to the land's agricultural potential reflects a very critical situation in the rural world:

- overpopulation in the traditional farming areas,
- frequently rudimentary agricultural techniques,
- poor natural resource exploitation structures.

The saturation of the good farmland areas leads to the well-known phenomenon, very widespread in Central America, of shifting cultivation carried out to the detriment of natural forest. The latter is permanently cleared and burned by the peasants who, as they cannot practice the fallow fields system, are obliged to abandon their plots after two or three years' successive cultivation as soon as yields drop beyond tolerable levels.

In addition, two peculiarities characterize this type of shifting cultivation:

. Firstly, livestock farming is considered the final object of forest clearance, since after a period of intensive cultivation the free areas are immediately taken in hand again to prevent forest regrowth and foster the development of grassy cover so as to allow extensive stock-farming over quite considerable areas (which, for lack of appropriate management, finally suffer irreversible degradation).

. Secondly, penetration of forests by farmers is often independent of logging, as in most cases agricultural settlement occurs before any logging has taken place.

To express the above in more concrete terms, according to Costa Rican statistics:

. 1 118 000 hectares of forest were cleared between 1950 and 1977, at a rate of 41 000 hectares per year;
. this rate increased to 60 000 hectares from 1977 to 1987 (offset by only a few hundred hectares of reforestation per year);
. natural moist forests presently total approximately 1 million hectares (about half of which has protected status as reserves and national parks), without taking into account about 300 000 hectares of swamp forests, severely degraded forests and mangrove swamps.

In Nicaragua, moist forest used to cover 4 million hectares and pine stands accounted for a further 300 000 hectares. The annual deforestation rate is around 3%, i.e. an estimated 120 000 hectares.

Lastly, in Panama about 70% of the country was wooded in 1947, but deforestation had reduced forest cover to 43% in 1987 (according to satellite images); the figures are as follows:

1970: 56%, i.e.: 4.3 million hectares
1980: 46%, i.e.: 3.5 million hectares
1987: 43%, i.e.: 3.3 million hectares

Annual deforestation rate: 1.6% between 1970 and 1987.

And there had been no management plant until the establishment of the Panamanian TFAP.

The catival forest, heavily exploited by the logging industry (up to 1986 it provided 50% of sawnwoods and 90% of plywoods ...), has suffered from uncontrolled utilization (clearing, fires): of the 70 000 hectares existing in 1970, only 30 000 remain today.

It is thus evident that the future of the American Isthumus forest is closely dependent on the solutions that will be adopted to meet the area's agricultural and human problems, and that any excessively narrow forest management approach is doomed in advance to failure.

The problem of the disappearance of forest resources in these countries can only be resolved if preliminary measures are adopted to stabilize the rural sector. These are well-known:

- credit aid for small farmers,
- improvement of agricultural techniques (fertilisers, mechanization, irrigation ...),
- reduction of extensive stock-farming (improved pastures, fodder storage ...),
- incentives (tax benefits) for the reforestation of marginal lands, aimed particularly at large landowners,
- etc. ...

forestry programmes, in terms of the conservation and management of natural forest formations, reforestation and agroforestry, can only be effective if implemented alongside these measures.

Given the "critical" situation, natural fallow can no longer be envisaged because of the long regeneration time required. It is thus indispensable to adopt artificial fallow systems involving various modes of planting fast-growing, high-yield wood species (for fodder, fuelwood and roundwood ...) so as to ensure the advantageous use of the available rural land and a good cost/benefit ratio.

The various artificial fallow systems belong to the vast domain of agroforestry techniques, many of which have been empirically practiced for a long time, as a matter of necessity, in the Central American countries.

Reforestation in the form of single-species or slightly mixed stands has the advantage of concentrating a high yield in a small area, and is the best solution whenever farmers exercise mild competitive pressure on land use.

This is the only feasible means to provide timber, roundwood or fuelwood in sufficient quantities from small areas. It also constitutes a very effective means of ensuring soil protection and restoration, and of reducing exploitation pressure on the major natural forests with a view to their conservation and management.

Hence, despite the multiplicity of technical, financial and land ownership problems that reforestation projects have to contend with, their successful implementation in the framework of national plantation programmes is absolutely indispensable so as to avoid the need to import wood products at high cost.

In the framework of a rational national development plan, forest plantations should preferably be established on land that is marginal from the agricultural standpoint (unsuitable for cultivation, severely degraded ...) but which also allows regular and easy timber extraction. The farmer-owner must have an economic interest and participate directly in the management of the stands; this means promoting "rural forestry" projects with government aid in the initial phases.

2. MEXICO

Of the original 29 million hectares of tropical forests, 21 million remained at the beginning of this century and almost 20 million were still standing in 1950.

During the fifties over 2 million hectares of forest disappeared, followed by a further 2.5 million between 1960 and 1975. Over this 25-year period deforestation thus proceeded at a fairly constant rate: around 200 000 ha/year.

The pace of deforestation then underwent a sharp acceleration to over 350 000 ha/year; the tropical forests had been reduced to 15 million hectares in 1976, and had shrunk to only 11.4 million in 1986.

This deforestation is the result of two types of human intervention:

- governmental programmes for the controlled settlement of "available" woodlands; and

- uncontrolled individual clearance due to shifting cultivation.

These "classic" forms of deforestation are, yet again, the manifestation of land-hunger in an extremely fast-growing population, and of overambitious government schemes unbacked by any preliminary general development plan for farmlands or for the territory as a whole.

After some small-scale inventories (the earliest of which date back to 1920 in the tropical zone), a general inventory of tropical forest resources was begun in 1964 with the creation of the National Inventory Department, with assistance from FAO.

Sampling was conducted at an approximate rate of 0.4% based on primary counting units each measuring 0.1 ha. This inventory was completed in 1971 for the forests in the States of Chiapas and Quintana Roo, and in 1984 for all of Mexico's tropical forests.

3. BELIZE

This country has a very low population density (an average of 8 inhabitants/km^2), and is almost entirely under forest (93%).

It would appear that little in the way of forest resource evaluation has taken place after the findings of the 1978 FAO Project. In earlier days, important botanical research projects had been carried out in the '20s, '30s and '50s.

The chief threats to Belize's forests are:

- fires, above all in pine forests. (It appears, however, that these have a positive effect on the pines' natural regeneration).

- the highly destructive tornadoes that sweep the country from East to West. Given their frequency (once every five years) and the width of the forests concerned, in statistical terms each forest compartment should be destroyed once every 45 years. Risk studies based on geographical location should make it possible to identify the least-affected areas, where forest management projects could be established.

- farming consumes more or less forest land according to the techniques practiced by the communities concerned:

  . clear felling, burning, stump-grubbing and permanent mechanized cultivation (Mennonites);

  . agroforestry (by the Amish community of 10 000 persons of Dutch origin, who practice an archaic life-style);

  . slash-and-burn cultivation (Mestizo and Yucatec Maya)

  . citrus (lemon) and banana plantations after total destruction of the forest.

- forest logging over-exploits certain species (Mahogany and Cedar).

4. THE CARIBBEAN - Example: PUERTO RICO

In the Caribbean Archipelago the deforestation situation varies greatly from one place to another, ranging from very severe in Haiti to relatively slight in Trinidad. Both deforestation and the inventorying of forest resources are intimately linked to the context of each island and country: the example of Puerto Rico is very eloquent in this regard.

The forest history of Puerto Rico from its discovery early in the 16th century to the mid-20th century is that of the gradual destruction of plant cover and soils, in three major phases:

- Settlement first cleared woodlands to make way for pasture, which in 1899 covered 55% of the island's surface, and crops. The large estates, located on the best and least hilly land, grew crops for the export market whilst the numerous small farms in the mountains practiced shifting cultivation of subsistence crops.

- At the end of the nineteenth century, coffee cultivation developed in the mountains on land previously considered unsuitable for cultivation. The forest cover rate plummeted to 20% in 1900, and only a third of the remaining stands are able to provide anything other than fuelwood.

- Forest clearance continued until 1950, under the pressure of rising population, the development of export crops, and above all of the economic crises which, with increased unemployment, brought about a return to a subsistence economy. The forest cover rate fell to 6% and erosion reached catastrophic levels.

Since the middle of this century, with the progress of economic development, the area under forest has been increasing due to the abandonment of marginal lands and a private reforestation movement on eroded lands.

The mangrove forests on the coast, which originally covered 24 000 ha, had stabilized at 6 000 ha in 1979. The causal factors of this reduction had been:

- initial cutting for fuelwood,
- subsequently, the agricultural use of these lands,
- and finally, the development of towns and ports.

Now that their protective role against marine erosion is better understood the mangroves are no longer subject to clearance, but they suffer heavily from cyclones.

The general forest inventory of the island was carried out in 1980 to provide information on the production potential of young secondary forests.

Due to population migrations and declining agriculture, the area under forest has increased considerably over the last 30 years. It now amounts to 275 000 ha, corresponding to a forest cover rate of 31%, but due to the island's mountainous relief only 130 000 ha are located in potentially productive zones.

The exploitable forest area is defined by 5 criteria:

- exploitable volume per hectare above 2.5 m^3;
- distance from nearest permanent road below 1 km,
- area held by a single title-holder above 5 ha;
- satisfactory physical conditions for exploitation;
- distance from nearest river or lake above 50 m, ...

This gives 31 000 ha of currently exploitable forest, i.e. about one quarter of the forest area in the production zone.

The rest of the production forest is very young, but there is enough standing timber stock to estimate that a protection and management programme would be sufficient to make it productive without any large-scale reforestation measures being required.

The available volumes, divided by types of forest, are as follows:

- abandoned coffee plantations : 53 m^3/ha
- secondary forests : 44.4 m^3/ha
- shade trees over coffee groves: 36.3 m^3/ha

The highest volume (73.3 m^3/ha) is found on deep volcanic soils. But the sawable volume is only one-tenth of the standing volume. What is more, the logs are of very poor quality, except in natural forest.

The floristic composition data is more favourable. With 547 naturai species and 203 introduced species, the flora is highly diversified, although 10 species account for 60% of the total volume. The fact that eight of these have been used as shelter for coffee plantations or for fruit production clearly reflects the man-rnade origin of the stands.

The inventory also investigated the forests' ownership. Approximately 85% of the land under forest belongs to private owners. In the public domain, the Commonwealth is the largest owner; with national parks and reserves, it holds virtually all the primary forest still in existence.

5. THE GUYANESE REGION

Suriname and French Guiana are representative examples of a context where human impact is (still) relatively slight.

SURINAME

Suriname has a small population which is, moreover, highly urbanized, as 80% of the population lives less than 30 km away from Paramaribo. The impact of agriculture on the forest is thus very low.

The existing problems are connected with bauxite mining, either due to the mines themselves or to the creation of large artificial lakes to provide cheap hydro-electric power for aluminium production.

The susceptibility to fire of the seasonal swamp forest on peaty soils during exceptionally dry years must also be mentioned.

Inventory campaigns to identify new areas for exploitation can be divided into three main periods:

- Between 1904 and 1925 the newly established Forests Department conducted inventories: chiefly in the forest at Mora in the North-West and in the deep forest along the Lawa railway.

- Between 1949 and 1959 the use of photo-interpretation techniques allowed a more ambitious programme, concentrated chiefly in the northern area of the country. The inventory covered 260 000 ha at a rate of 2%, with a subtraction diameter of 25 cm. The commercial volume per hectare is of the order of 25 to 30 m^3.

A special inventory of permanent and seasonal swamp forests has also been carried out. The areas rich in large-diameter *Virola surinamensis* have been exploited by BSH (Bruynzeel Wood Company).

. In the seventies, FAO gave its assistance for an inventory of the South-West and South-East zones. The total area inventoried was 440 000 ha, with a sampling rate of 0.25% and a subtraction diameter of 25 cm. The total commercial volume is around 45 m^3/ha and the volume actually felled is estimated at 16 m^3/ha.

Other smaller inventories have also been carried out, both by private companies with a view to exploitation and by the Forestry Service for forest research purposes.

FRENCH GUIANA

Until 1975 the agricultural area of the territory was 3 300 ha, i.e. 0.04% of the total land area. The prevailing farming method was "slash-and-burn" subsistence farming.

A rural development programme ("Green Plan") was initiated in 1975 to meet the local market demand for food crops, fruit and meat, and to develop some export crops (rice, soya, cassava, etc. ...).

In 1988 the agricultural area had increased to 15 000 ha (0.15% of the total area), but the clearance rate (900 ha per year) was decreasing due to the difficulties encountered in beef production. Only rice-growing in polders in the marshlands had really developed, whilst traditional food-crops remained very stationary.

Guyana is thus in a most unusual agricultural situation for South America. No logging concern runs the risk of seeing its concession invaded by farmers.

What is more, the land tenure system is uncomplicated. Virtually all the available land is private State property, so farmers must obtain a concession or long lease from the administration before they can clear it.

After the botanical reconnaissance work conducted in the eighteenth century under AUBLET, and until 1960 under BENA, the first inventories were carried out between 1952 and 1957, over 50 000 ha at a rate of 0.5%, by the BAFOG (Bureau Agricole et Forestier Guyanais) to supply its pilot saw-mill at St. Laurent du Maroni.

In 1962 the Forestry Service began a 1/1 000° sampling campaign in the North of the territory, extending 100 km inland from the coast.

Subsequently, in 1974-75, the ONF (Office National des Forêts) and the CTFT (Centre Technique Forestier Tropical) inventoried 120 000 ha at a rate of 0.8% to determine the paper pulp and timber potential.

In 1976, in the framework of the "Green Plan", new inventories were conducted over 412 000 ha, at a sampling rate of 0.2%.

Thanks to these inventories, it was possible:

- to estimate the "useful mainstem" volume for each zone;
- to determine the variability of the forests' floristic composition;

- to establish a unified paper-pulp table giving the "gross mainstem" volume for trees of less than 80 cm in diameter.

For example, the findings of the 1976 inventory of the KOUROU SINNAMARY region make it possible to estimate the mean exploitable standing stock, i.e. 20 trees per hectare for a volume of 70 m^3 with an exploitable diameter of 50 cm.

In the short term, the information obtained is adequate with regard to the exploitation problems of forest enterprises of all types. But from the scientific standpoint, and in the long term, from the economic standpoint also, it is necessary to expand the inventoried zone on both sides of the forest accesses that are progressively opened up. The ONF has been engaged in this work since 1986.

6. THE AMAZONIAN COUNTRIES

BRAZIL

Without any detailed discussion of all the negative aspects that the problem of deforestation entails, we need only mention that 97% of the 61 million hectare Atlantic coastal forest has been converted to farmland, and that this must be prevented in Amazonia, where the deforestation figures vary according to the survey methods used: fire estimates based on satellite images with a wide margin of error. The also vary in accordance with the reference zones considered: legal Amazonia or closed moist forest, and with the observation dates and periods... The result is a sort of war of conflicting statistics, and to avoid getting caught up in these hostilities we wish to stress that the nature of the problem does not change, whatever the deforestation rate may be (5 or 15%).

We must recall that in addition to agricultural clearing the Amazonian region contains important mineral deposits, whose extraction seriously imperils the forests in the regions concerned (the opening up of roads, mining and construction timber requirements, clearing for agricultural uses, ...).

The forest inventories, carried out principally by SUDAM (Superintencia do Desenvolvimiento de Amazonia) with the assistance of the former IBDF (now absorbed by IBAMA: Instituto do Meio Ambiente et dos Recursos Naturais Renovaveis), dealt above all with upland forest regions on the verge of agricultural or industrial colonization. These inventories are very limited in scope and are not easily comparable. The potential of the Varzea, on the other hand, has never been established although this type of forest is the chief source of timber in Amazonia.

Considering there are around 500 tree species in the Amazonian forest, only 5 to 8% of them are exploited. The most sought-after in the upland forests belong to the Meliaceae family.

BOLIVIA - COLOMBIA

To the best of our knowledge, no statistics are available for Bolivia with regard either to already exploited areas, or to the area of forested land cleared, deforested or given over to land settlement.

Nonetheless, deforestation due to settlement by the populations of Andean origin occurs on a large scale. It was initially encouraged and guided by governmental measures, and subsequently the pace of deforestation due to shifting cultivation grew more rapid because of the low and short-lived fertility of the soils in question.

The situation is the same in Colombia, in spite of the Tropical Forest Action Plan drawn up for this country (TFAP).

ECUADOR

In this country the coastal forest could have constituted an important managed resource for the country's wood industries, but this opportunity has been lost because of the conflict between the forest industry and legal or illegal land settlement for farming.

The deforestation rate is uncertain, but it has been ascertained, for example, that over 418 000 ha of the northeastern forests (Amazon basin) had been occupied between 1971 and 1975 by farmers (with no property title) using the roads opened up for oil drilling.

This forest shrinkage also affects the protected stands, since the Ecuadorian Government is currently directing its international aid requests and action towards watershed management so as to preserve its hydro-power resources and lengthen the working life of its dams.

Knowledge of the resource is very patchy, as the forest inventories are localized and seldom updated; we may mention the inventory carried out in 1975 and 1976 in the South of the country, concerning 25 000 ha of mangrove swamps, 200 000 ha of "dry" closed forest, 1 500 000 ha of sub-Andean lands and a million hectares of Amazonian forest.

VENEZUELA

The Venezuelan forests are subject to two types of forest clearance, one due to farming and the other to mining. The small isolated patches of forest in the West of the country bear witness to a progressive and irreducible process of deforestation: it has been estimated that between 1963 and 1979 at least 1.2 million hectares of forest were cleared for agriculture and that the pace of this phenomenon has considerably increased since then. Today the well-known forest reserves of Ticoporo and Caparo, where some important forestry research had been conducted (particularly on plantation species by the School of Forestry of the University of the Andes at Meria) are living on borrowed time: 95% percent of Caparo's area, and at least a third of that of Ticoporo, are occupied by a population of migrant farmers.

In the East of the country, the danger of destruction is linked above all to the gold and diamond mines, especially in the Sierra d'Imataca Reserve, the largest and best-known in the region: in 1985, 250 000 ha of its area had already been ceded for mining purposes, and there exists an imminent danger of large-scale deforestation.

PERU

The basic factor in the destruction of Peru's Amazonian forest is the population explosion due both to natural growth and, above all, to migrations from the Andes.

The situation is today particularly dramatic in four areas, which exemplify the major forms of attack to which the forests are subject.

The central jungle and Huallaga Central - Bajo Mayo zones are located in the Andean Piedmont, and those of Pastaza-Tigu-Amazonas and Madre de Dios are situated on the Amazonian plain.

Over the last 50 years the central jungle has undergone the onslaught of a classic pioneer farming front advancing in the wake of new roads. But on these steep slopes the problems of erosion, and of landslides above all, reach catastrophic proportions. It is estimated that only 20% of the million hectares of deforested land are still in agricultural use.

In the Huallaga Central - Bajo Mayo district the terrorism practiced by Sendero Luminoso (Shining Path) and the narco-traders creates a situation of total insecurity. The clandestine coca plantations are estimated at 300 000 ha.

Peru's oil-wells are concentrated in the Pastaza-Tigre-Amazonas region. This industry is heavily polluting, due to the heavy metals that are washed down the rivers. Their concentration through the food chain makes the local fish inedible. Moreover, the soils of the forests subject to six months' seasonal flooding are contaminated and may become unsuitable for cultivation.

The soils of the Madre de Dios region contain about 1.5 g of gold per m^3, which gives them an estimated potential of 1 500 t. The region is consequently in the throes of a full-scale gold rush, with all its attendant damage to the natural environment (road-building, pollution of rivers by gold-washing sludge, shifting cultivation to provision the sites, ...).

At present, 300 000 ha are being deforested per year, 60% of which are in the jungles of the Andean foot hills, where the slopes are steep and the soils consequently vulnerable. Over the last decade the Amazonian population has doubled, and it is currently estimated that 51 000 km^2 have been destroyed overall. If this situation continues, 11 million hectares of Amazonian forest will have disappeared by the year 2000.

In the framework of the FAO-UNDP forest management project for the Von Humboldt national forest, on the Amazon basin plains, an inventory has been carried out on an experimental basis over an area of 200 000 ha.

Its findings revealed that the forest's floristic composition was very heterogenous, but showed great uniformity with regard to the volumes actually exploited. The inventory

covered 300 species, but only 28 of these accounted for 70% of the total volume. Three-quarters of the commercial volume was provided by 21 species, and regeneration growth of 15 species constituted 85% of the stem count. The volume actually exploited increased from 15 to 30 m^3/ha during the course of the project, as 20 new species were added to the list of valuable commercial species.

No other exploratory survey inventorying a large area has been reported.

7. GENERAL CONCLUSIONS

In most of these countries, deforestation is a matter of concern and a very sensitive issue from the political and ecological standpoints, even if not always of catastrophic proportions. But some regions, such as Central America, face a highly critical situation due to the disappearance of protection forests on steep slopes that play a vital role in soil conservation.

The classic scenario is as follows: opening of tracks, land settlement with forest clearance, then cultivation for a few years, followed by extensive grazing.

This process is fostered by several factors:

- population increase (in some cases exceeding 3% per annum),
- lack of economic value placed on forest stands,
- the most serious are the structures of the agricultural economy (a few large landowners freezing access to farmlands and opposing agrarian reform) and the governmental policies of certain countries, which incentivate agricultural development to the detriment of forests.

Deforestation is not caused exclusively by farmers' land-hunger; mining is also an important factor in the destruction of natural forests.

The consequences of deforestation and its multiple implications with regard to forest management are discussed in the following chapter and in the conclusions.

V. ECONOMIC FACTORS AND WOOD PROCESSING

1. GENERAL INTRODUCTION

The chief object of this study is the management of the moist forests of tropical America. The documents drawn up for each country and serving as reference material for this purpose were thus concerned essentially with forest issues.

However, we cannot overlook the fact that forest problems have their origin in the economic and social situations of the countries concerned: if it is true that "there is no wood without trees", it is equally true that there are "no trees without woods".

Only the properly evaluated economic interest of the benefits that forests can provide (and our present economic methods leave us very poorly equipped to quantify these benefits) can make it possible to decide to allocate the necessary and adequate human, technical and financial resources to forest management, protection and valorization.

If forests must be preserved, and one has any real intention of doing so, this is principally in order to perpetuate their benefits, which include in the first rank the satisfaction of wood use needs, whether for fuelwood, timber, roundwood or industrial wood, which should therefore be accurately known.

In other words, the resources necessary for forest management can only be granted to foresters by the political establishment, and if the latter is not adequately informed (by economists or experts) of the importance of this work for the present and future population, the responsibility must be borne by the forestry profession (in the broadest sense).

Thus, despite the limited quantity of information collected, we consider it indispensable to provide our readers with some rudimentary notions on the economics of wood and its processing in tropical America.

We are very much aware of the limits of this exposition, which cannot be more than a very modest introduction to the issues it touches upon.

In the light of this survey, three fundamental observations must be made:

(a) The economic interest of the preservation of tropical American forests has not yet been firmly established. This must be done, because otherwise the pursuit of mining will encounter only minor obstacles, and it is impossible at this time to determine the consequences to which this will give rise.

(b) The wood industries of tropical America appear very little known, as they have been the object of only a few surveys (knowledge of the existence of which extends beyond the frontiers of the country concerned), which are in most cases very limited in scope.

It would thus be necessary to foresee and implement a series of studies of the timber (and fuelwood) sector in each of these countries where information is least available.

It is in fact essential to know how the populations' forest produce and wood needs are evaluated. How is harvesting planned, conducted, and recorded ...? What sequences are involved, and who are the intermediaries and direct participants in the processing and marketing of forest produce and wood products? How are these activities perceived by the local administrations (forests, industry, crafts, domestic trade, foreign trade, finance, ...) and what policies have been formulated for the wood sector of the economy?

(c) The tropical American countries covered by this survey vary greatly in their forest and wood utilization situations.

But as a whole, and this is indeed paradoxical, since they possess a very considerable part of the planet's tropical forest resources (651.6 million hectares of closed forest, i.e. 56.0% of the corresponding areas of the planet in 1985, with a population of only 335.8 million inhabitants), the countries examined in this survey are not fully able to satisfy their own wood needs, and their a balance of trade deficit in this sector totals US$ 242 million. (See table overleaf).

Leaving aside the details which readers will find further on in the specific paragraphs on each country, we merely note that only five of the 17 geographic units surveyed have a trade balance surplus for these products: above all Brazil (with a surplus of over US$ 730 million), followed by Bolivia, Guyana, Honduras and French Guiana. The other twelve have deficits that amount to a cumulative total of around US$ one billion (996.9 million in 1987).

We think that, although this chronic deficit may in some cases be hard to overcome (as in Panama and El Salvador), self-sufficiency should nonetheless constitute a priority goal within the reach of most of the countries concerned, on the condition that a degree of rationalization be introduced into the harvesting, processing plant supply circuits and distribution networks of wood products. There will remain the difficult problem of the paper and paper pulp deficit.

But wood harvesting and processing (often on an artisanal basis) are sectors of the economy which should attract the attention of the governments of these countries, as they can provide a positive and solid contribution to the development of the economic fabric, particularly in rural areas.

SOME BASIC ECONOMIC INDICATORS
(Second half of the 1980s)

Country or geographic unit	Value of forest product imports US$ 1 000	Value of forest product exports US$ 1 000	Balance of foreign trade for forest products US$ 1 000	Area covered by closed forests (1 000 ha)	Population (millions)
Guyana	2 710	8 000	+ 5 290	18 465	0.8
Suriname	8 310	2 666	- 5 644	14 818	0.4
French Guiana	1 087	2 169	+ 1 082	3 895	0.1
Subtotal	**12 107**	**12 835**	**+ 728**	**42 178**	**1.3**
Brazil	232 957	963 373	+ 730 416	350 200	141.4
Bolivia	5 100	18 999	+ 13 899	43 570	6.7
Colombia	110 887	14 011	- 96 876	2 300	29.5
Ecuador	107 690	15 342	- 92 348	12 550	9.9
Peru	57 109	3 355	- 53 754	68 320	20.2
Venezuela	246 048	0	- 246 048	31 245	18.3
Subtotal	**759 791**	**1 015 080**	**- 255 289**	**548 185**	**22.6**
Belize	3 193	657	- 2 536	1 309	0.2
Costa Rica	61 103	12 361	- 48 742	1 313	2.6
El Salvador	21 525	2 597	- 18 928	118	4.9
Guatemala	43 822	9 458	- 34 364	3 992	6.4
Honduras	24 076	26 251	+ 4 175	3 342	4.7
Nicaragua	10 566	2 569	- 7 997	3 900	3.5
Panama	84 885	676	- 84 209	3 985	2.3
Subtotal	**249 170**	**56 569**	**- 192 601**	**17 964**	**26.6**
Mexico	319 305	13 884	- 305 421	43 270	81.9
Subtotal	**568 475**	**70 453**	**- 498 022**	**61 234**	**108.5**
TOTAL	**1 340 373**	**1 096 368**	**- 242 005**	**651 597**	**335.8**

2. THE ISTHMUS AND CARIBBEAN COUNTRIES:

COSTA RICA - NICARAGUA - PANAMA - EL SALVADOR - HONDURAS - GUATEMALA

The state of the resource

Without repeating what has already been said, these countries can as a whole be considered to have a limited potential. It should, however, probably prove sufficient to satisfy their populations' demand for wood, even though some limited international and interregional transfers may be required.

The achievement of self-sufficiency will necessarily require some vigorous forest plantation schemes (particularly in Costa Rica, El Salvador and Panama), and the rationalization of harvesting in natural forests with regard both to planning (management and development plans) and to the methods and techniques employed.

Harvesting

Today harvesting is principally oriented towards fuelwood: in these countries harvesting for fuel and charcoal accounts for a total of over 24 million m^3 (24.15 m^3 in 1987), which covers 57% of the region's energy requirements. Wood is the sole household fuel used by 72% of the population, and still accounts for 35% of industrial fuel consumption.

In the same year, less than 2.4 million m^3 of timber was cut, and 360 000 m^3 of other roundwoods (for miscellaneous uses and mines).

Two countries dominate the field in timber exploitation: Nicaragua and Honduras, both with production levels in the vicinity of 800 000 m^3/year. Costa Rica and, to a lesser extent, Panama each produce less than half this amount (275 to 300 000 m^3/year).

Species harvested:

The chief commercial or marketable species are obtained principally from the Atlantic moist evergreen forests:

COSTA RICA: *Prioria copaifera, Carapa guianensis, Dipterix panamensis, Simarouba glauca, Cedrela odorata* and *Cordia alliodora.*

PANAMA: as well as those listed above, the following are also logged: *Swietenia macrophylla, Bombacopsis quinatum, Piethecoelobium excelsum, ...*

The list is even longer in the case of Honduras, Guatemala and Nicaragua, which harvest their pine-forests as well.

El Salvador logs only *Pinus oocarpa, Gliricidia sepium, Inga* spp., *Cordia alliodora, Enterolobium cyclocarpum* and the mangrove species *Rhizophora mangle* and *Laguncularia racemosa.*

Wood processing

Apart from fuel, which accounts for most of the harvest, the wood logged is processed almost exclusively (93%) into sawn timber by a multitude of more or less seasonal sawmills, small or medium-sized (10 to 20 m^3/day and with less than 5 employees), usually inadequately outfitted with old and inefficient equipment. In addition to this type of enterprise, oriented chiefly towards the rural and minor urban markets, there is also a more efficient industrial sector, with large, well-equipped saw-mills, but it is afflicted by a chronic log supply problem and (usually) poor organization.

Sawn timber production totals about 1.2 million m^3/ha (1.167 in 1987), approximately 19% of which is exported (particularly from Honduras, where pine remains competitive in spite of the already mentioned handicaps with regard to the state and accessibility of the resource).

This industry suffers various problems:

- the relative lack of government interest in forests and wood processing activities (uncontrolled access to land by peasant farmers is a feature of these countries);

- overexploitation of the most accessible forests;

- the heavy cost of access infrastructures (roads and bridges) that are insufficiently utilized since logging is seasonal only (dry season);

- enterprises that are somewhat poorly managed and employ an underskilled labour force of temporary workers, the consequences being:

  . insufficient valorization of the products,
  . an archaic and defective marketing system;
  . narrow range of species exploited;
  . very poor planning of operations;
  . poorly maintained and obsolete plant;
  . badly utilized and inefficient methods and equipment, high harvesting and haulage costs;
  . all resulting in an overall inability to assure a regular and low-priced supply of products of adequate quality for the processing units.

Considerable improvements could be quickly brought about in this situation by applying the measures already indicated in several reports, on the condition that in each country those in charge (in public administration, and above all in the private sector) are fully convinced of the need for same and have sufficient means at their disposal.

There is also a small plywood industry (totalling 64 000 m^3/year for all five countries, i.e. one unit per country) which supplies the domestic demand (see case study below).

Other types of panels are manufactured in only one of these countries (Costa Rica), which produces about 15 000 m^3/year of particle-board and about 7 000 m^3 of veneer leaves (sliced), approximately a third of these products being exported.

The domestic demand for wood materials is thus satisfied without significant imports (25 000 m^3/year, 90% of which is sawn timber and the rest plywood).

The second processing sector consists of small artisanal workshops (furniture-making, joinery, carpentery, tool-making) that constitute a very lively economic fabric which should be encouraged, developed, and assisted towards technical amelioration, It supplies the domestic market with products (furniture, etc.) of rustic appearance but adequate quality, that have the advantage of being affordable by a large portion of the population and meet their essential needs (it would be a mistake to discourage this sector or to press it into large-scale exports).

These workshops are in the mechanized craft stage (using mechanized equipment for machining, but assembling and finishing the products by hand), and it is through this type of processing unit that realistic and solid development could be achieved in this sector for the countries in question.

Impact on the national economy

In Panama, for instance, the TFAP reveals that the National Accountancy System is not able to compute the value of forest products; in addition, processed wood products are ascribed an "original forest" value that fails to take into account the material's yield (necessarily less than 100%) in the manufacturing unit.

In addition, statistics on the harvesting of fuelwood, charcoal, poles and lumber for local use seldom if ever exist, although this type of harvesting accounts for 80% of wood exploitation in the Isthmus countries.

The underevaluation of this sector is so great that products of forest origin (forest industry) are estimated at not more than 1% of the GDP in Panama.

This underestimated and apparently very low contribution, as compared to that of agriculture and animal husbandry, had led to a prejudice against forests, which were (and still are) viewed as an obstacle to national development, or at any rate to increasing the GDP.

An example of forest logging

This concerns logging, commenced in 1985, in the forested part of the river Sabales, an affluent of the San Juan river in Nicaragua.

The chief object of this logging concern conducted by COREX S.A., a direct agency of CORFOP, is to supply the country's one and only veneer-peeling plant, located at Tipitapa, 25 km from Managua at the far northeastern end of Lake Nicaragua. This processing unit, which was nationalized in 1979 and placed under CORFOP's supervision, produces around 10 000 m^3/year.

As the zone in question had undergone only small-scale family logging prior to COREX S.A.'s arrival, a certain number of stems of *Cedrela odorata* or *Swietenia macrophylla* are available for logging. But most of the cut is made up of *Virola sebifera*, *Carapa nicaraguensis* and *C. guianensis*, *Terminalia amazonia*, *Vochysia hondurensis*, *Manilkara sapota*...

The logs are floated down the San Juan river and right across Lake Nicaragua (with a last haulage phase by timber-truck to Tipitapa that significantly increases the overall cost).

In 1988, the logs were collected by Caterpillar-type tracked vehicles of up to 125 HP and conveyed to the flotation yard by Mack timber-tucks (200 HP). The main access track was opened by the only D 65 (140 HP) in running order, and the fleet of timber-trucks and skidders numbered only some fifteen operational vehicles, whose maintenance was assured by Swedish aid covering, in particular, the supply of spare parts.

In spite of these constraints and difficulties, this operation manages to extract 30 to 40 000 m^3 of logs per year, although it operates only in the short dry season from February to early May.

The mean volume extracted from the forest is around 10 m^3 per hectare, which means that the average annual cut area is from 4 000 to 5 000 hectares, fully inventoried in advance to identify the valuable tees that have attained harvestable size.

The most damaging aspect is that, for each forest hectare logged, 30 to 40% of the basal area is destroyed due to technical and organizational shortcomings:

- in the first place, the lack of road infrastructures allowing year-round access to the forest imposes narrow seasonal limits on logging (only four months per year), and the chief consequences of this are: underutilization of equipment, interruption of log supply, considerable technical unemployment, the need to use temporary (and poorly-skilled) personnel, and work (especially exploratory surveys) that progresses by "fits and starts" under bad site conditions;

- the above is aggravated by collection, transport and track-opening fleets that are under-dimensioned, obsolete (with a few exceptions) and hard to maintain and repair under local conditions.

MEXICO

Logging in tropical forests has, since the beginning of this century, been based preferentially on the extraction of two Meliaceae, *Swietenia macrophylla* (Caoba) and *Cedrela odorata* (Cedro Rojo), by both domestic and foreign enterprises.

Between 1950 and 1960, annual tropical wood production amounted to 69 000 m^3 of valuable timber (almost all Caoba and Cedro Rojo) and 64 000 m^3 of less valuable species. This level has remained more or less the same as regards the valuable woods: 86 000 m^3/year.

The exploitable diameter is 55 cm for Caoba and Cedro Rojo, and from 35 to 40 cm for the other species. There are about thirty of the latter, the most frequently marketed of which are:

Maculia (*Tabebuia rosea*), Chaca (*Bursera simaruba*), Jobo (*Spondias monbin*), Saac chaca (*Gilibertia arborea*), Amapola (*Pachira fastuosa*), Ramon (*Brosimum alicastrum*), Ceiba (*Ceiba pentandra*), Pich (*Enterolobium cyclocarpum*), Machiche (*Lonchocarpes castilloi*), Tzalam (*Lysiloma bahamensis*), Chechen negro (*Metopium brownei*), Siricote (*Cordia dodecandra*), Granadillo (*Dalbergia retusa*), Pucte (*Bucida buceras*), bari (*Calophyllum brasiliense*), and Guanacaste (*Schizolobium parachybum*).

In Mexico, most of the wood harvest is for fuelwood (14.5 million m^3/year).

As regards timber wood, 90% of the 4.3 million m^3 exploited per year is from coniferous forests (Pines); the same applies to industrial wood (pulp-wood: 2.5 million m^3/ha) and pit-props.

In the wood industry, sawing is by far the most prominent activity, and produces 2.4 million m^3/year, including 170 000 m^3 of laminates. A small quantity (330 000 m^3) of imports supplements the local market deficit. The amount of products exported is very small.

The second place is occupied by the paper-pulp industries. They produce around 600 000 tonnes/year, which is still not enough to satisfy the domestic demand (350 000 tonnes/year are imported).

Paper and cardboad manufacturing (2.6 million tonnes/year), although rapidly increasing (it has doubled since 1976), is also insufficient for the domestic market's demand (imports total 150 000 tonnes/year).

The production of wood-based panels is dominated by particle-boards (425 000 m^3/year) and plywood panels (290 000 m^3/year). These two tyes of panels are produced for the domestic market (the particle-boards in their entirety, and 95% of the plywoods); a few imports (15 to 20 000 m^3/year) make up the domestic supply deficit in relation to demand.

According to a survey conducted by CNIDS, 126 plywood factories and 165 sawmills utilized tropical woods in Mexico in 1987, but were operating far below their maximum capacity.

It is very probable, although we have not been able to obtain any definite infomation on this point, that the domestic second processing market (especially for furniture and joinery items) is very active and occupies a large number of small- or medium-sized workshops in

or near urban centres (particularly in the Valley of Mexico where 40% of the country's industry is located) and an equally large number of intermediaries and tradesmen.

BELIZE

A total of 45% of Belize's forests belong to private companies, and only the most inaccessible or least productive are State-owned.

Belize's productive forest (especially as regards Mahogany) is owned almost entirely by a small number of private operators. A single company (Belize Estate and Produce Company) held 253 800 ha in 1984. This situation considerably limits the possibility of government control of logging, although the companies themselves must feel the need to ensure the permanent availability of these natural resources.

For over 200 hundred years, Belize's chief export has been Mahogany (*Swietenia macrophylla*) and Ceder (*Cedrela odorata*), in the form of logs. They are exploited at a rate of 2 to 5 stems per ha in the forests concerned, i.e. around 5 to 6 m^3/ha on average.

For approximately the last hundred years, the natural pine forests (*Pinus caribea*) have also been subject to intensive exploitation, and the young stands are all too frequently damaged by fires. The production policy followed since 1951 gives rise to the rapid degradation of the stock, with regard not only to Mahogany and Cedar, but to the Pines in the natural stands as well.

The other products extracted from Belize's forests were:

- achras latex (above all from *A. zapota*) for chewing-gum manufacture (which dropped from 235 tonnes/year in the early 1930s to zero in 1988); and

- seeds of *Pinus caribaea, var Hondurensis* (decreasing) and of *Pinus patula var. Tecunhmanii* (constantly increasing).

The wood harvest consists chiefly of fuelwood (126 000 m^3 in 1987), but from the value standpoint timber (29 000 m^3 in 1987, still comprising over 50% of Mahogany and Cedar), is heavily predominant.

The production and exportation of logs have dropped considerably over the last ten years (respectively 46 000 and 7 000 m^3 in 1980, as compared with the figures given above for 1987).

The processing industry is limited to saw-mills, whose production and exports are also decreasing (22 000 m^3 produced and 2 000 m^3 exported in 1985, 14 000 m^3 produced and 1 000 exported in 1987).

Serious efforts are still required to extend the range of wood species used locally and to increase awareness of the economic interest of this forest so that adequate means can be allocated to its development or maintenance.

PUERTO RICO

Puerto Rico can provide a snapshot of the economic factors and the wood processing industry typical of most Caribbean Archipelago countries.

Investments in the processing industries are limited by the per hectare low volume of commercial spieces and the absence of forest infrastructure.

Haulage by articulated tractors causes erosion and cable systems are too costly.

Domestic production is consequently very low, and all wood-derived products are bought ready-made in the United States. The trade deficit of this sector is around US$ 500 million; it is the second highest import item after foodstuffs.

3. THE GUYANESE REGION COUNTRIES

SURINAME

Forest exploitation: until 1947, forest exploitation was limited to the felling of the most valuable and easily accessible trees by small private operators, working the edges of farming areas and along river banks. The work was carried out very largely by hand and the country imported wood.

After the war production increased under the initiative of the Forestry Service and BSH, first reaching self-sufficiency level and subsequently allowing quite large exports. Management efforts first concentrated on plantations, until 1978-80, then extended to the management of natural forests.

The utilization of natural stands depends on their commercial wood content and on logging conditions.

Mangrove forests play a primary role in protecting the coasts from erosion, and are a source of fuelwood.

The freshwater swamp forest provides mainly pulp-wood (*Virola surinamensis*). Logging conditions, which do not yet allow much mechanization, are very difficult. The system is as follows:

- the trees are felled by chain-saw,
- the logs are launched by winch into channels,
- they are then floated down the rivers.

The volumes currently extracted are around 2 500 m^3 per year.

In the swamp forests, harvesting is virtually limited to *Carapa* spp. and occasionally *Mora excelsa*, *Tabebuia serratifolia*, *Eschweilera* spp. and *Hura crepitans*. The volumes cut depend to a large extent on the market outlets (Mora for the western railway sleepers).

Logging is concentrated in the upland forests according to the richness of their stock of commercial species. The exploitation system is traditional:

- the trees are felled by chain-saw,
- the logs are collected in short lengths by wheeled articulated tractors
- they are then transported on roads built by the Forestry Service, and finally floated down rivers.

The industries are concentrated in the coastal plain around Paramaribo and Nieuw Nickerie. Some thirty small saw-mills work chiefly for the domestic market, but the sector as a whole is dominated by BSH.

With its two modern saw-mills and its plywood and particle-board factory, it accounts for 50% of sawnwoods and 100% of panelboards, and is the only significant exporter.

Production was concentrated on ten species until 1970, but has since diversified, and today 30 species are in regular use. After reaching 300 000 m^3, the harvest has dropped to 200 000 m^3 in the last few years, but only 8% is exported in the form of logs. Wood is traditionally very widely used in housing, but at present, due to the virtual monopoly of BSH and the poor structure of the wood processing sector, sawn timber has become prohibitively expensive for low-cost housing.

Logging costs

The mobilization costs are high, due to the low number of exploitable trees per hectare, the distance from processing plants and the poor organization of harvesting operations. The average cost per m^3 of logs delivered to the saw-mill yard is estimated at US$ 80-90, broken down as follows:

inventory	3%
roads	17%
felling	5%
collection	35%
road transport	13%
floating	9%
taxes	7%
supervision	11%

Better-organized collection could reduce this item by 20%.

The CELOS Silvicultural System (CSS), described in the "CASE STUDY", has not yet been applied on a full-scale basis. The trials covered 200 ha and the costs are estimated at US$ 100-140 per hectare. The productivity gain is estimated at 1 to 2 m^3/ha per year, i.e. an extra 20 m^3 in 20 years. A promising productivity gain is thus obtained at a lower cost, even though there is no market for the less-valued species.

The markets

About 75% of the total production, expressed in m^3 of round wood is used locally. The rest is exported either in the Caribbean or to Western Europe.

- The sawnwoods are sold chiefly on the domestic market. Only 10% are exported.

- 60% of the plywoods and particicle-boards manufactured by BSH are exported to the Caribbean area, despite competition from South-East Asian products.

- 80% of the harbour-works timber is exported to the Netherlands, and the rest to Europe.

In the last few years the wood industry has lost portions of its market in the local building industry, due to loss of competitivity in relation to other building materials, whilst exports are stagnating.

FRENCH GUIANA

Forest utilization and forest industries: Guyanese forest production had for a great many years been centered around two harvesting operations:

- the extraction of rosewood essence by distilling chips from the wood of a member of the Laureaceae family (*Aniba parviflora*);

- harvesting of balata rubber by the bleeding and coagulation of latex from the boles of *Manilkara bidentata* (Sapotaceae).

Both experienced heavy cyclic fluctuations in production levels due to price variations on the international markets and labour problems (the "gold rush").

The exhaustion of the resource and the creation of synthetic products brought about the decline and subsequent disappearance, in the sixties, of these two harvests.

Until 1960 the Guyanese forest economy remained embryonic (sawn lengths, artisanal saw-mills) although the BAFOG (Bureau Agricole et Forestier de Guyane) had already carried out technological trials and set up a pilot saw-mill.

Between 1960 and 1970, the arrival of large logging concerns operating in Africa and seeking opportunities for geographic diversification, at a time when the African nations were gaining their independence, increased production leaps and bounds. It reached a peak of 70 000 m^3 in 1969. The wood was exported in logs to the European market, as only the Rougier company had set up a veneer-peeling plant (which operated until 1986). But the difficulty of extraction, the low volumes available per hectare and the cost of labour induced these large logging concerns to pursue their activities in Africa or to shift to Southeast Asian, and in 1970 the volume of logs extracted fell back to 30 000 m^3.

From 1976 onwards, the "Green Plan" gave new impetus to forest activities through three initiatives:

- The paper-manufacture projects, which did not progress beyond the feasibility study phase as they proved unrealistic from both the economic and the sciological standpoints, did lead to the inventory of over 400 000 ha.

- The peeling and plywood industry regained some ground but the factory was closed in 1986.

- The establishment of a saw-mill was made the condition for obtaining forest permits, and along with a whole series of financial assistance measures made it possible to stabilize the volume at around 80 to 10 000 m^3 in logs. These are fully processed on the spot to supply the Caribbean market and a rapidly growing local market to supply the large public works projects under way here.

The second processing industry is beginning to develop, in particular through the construction of wood frame houses and the making of wooden floors and mouldings.

The breakdown of saw-mills according to size was as follows in 1987:

Production capacity	Number operating
10 000 to 20 000 m^3	5
5 000 to 10 000 m^3	4
less than 5 000 m^3	6

Markets for different products: between 1960 and 1980 the exporting of logs was the most remunerative outlet for the best organized enterprises. Since then the Public Authorities have made an effort to orient production towards local processing so as to give forest products a higher added value and to develop industries in Guyana to meet local needs.

In 1980, 48 100 m^3 of logs were exported as against 227 m^3 in 1987. The trend for sawn timbers is naturally the reverse: 6 500 m^3 exported in 1980 as compared to 15 018 m^3 in 1987 (sawnwoods and finished products).

Today most of the data obtained concerns "saw-milling", i.e. the production and marketing of sawn timber, planks and planed products, pre-machined in some cases.

The other processing sectors were still only marginal in 1987 and eluded statistical measurement.

* Sawnwood market: The domestic market, which absorbed over 60% of overall production in 1987, continues to grow thanks to the pace of building activities.

Over 80% of the sawnwood sold on the Guyanese market goes to this sector. Since 1985 the construction of wood frame houses and the use of roof shingles have assured a market for species previously considered as secondary (Gonfolo and Wapa).

The demand for sawnwood for carpentery, industrial joinery, door-frames, etc. rose considerably with the commencement of the large-scale building works connected with the Space Centre extension programme. The remaining 20% of the sawnwoods are used by the artisanal furniture-making trades. This diversified second-processing industry is likely to expand in the coming years.

The export market is dominated by the French Antillas (95% of sawnwood exports). There are a number of problems with marketing of these products: unfamiliarity of the woods on the international market, difficulties in exporting adequate quantities of sawnwoods or other products on a regular basis...

* Markets for other wood-derived products: In 1987, the majority of the machined products (1 800 m^3) was absorbed by the local market, as against only 500 m^3 despatched to the Antillas, which remain the only export outlet.

The manufacture of veneers and plywoods ceased entirely in 1986 when the only manufacturing unit was closed down. All panelling must now be imported from metropolitan France or Brazil (3 000 m^3 in 1987).

The potential demand on the local market, together with the Antillean market, should be between 4 and 6 000 m^3/year if the building industry forecasts are accurate. Guyana could produce 10 000 m^3 per year, if the current studies and manufacturing unit projects prove feasible.

4. THE AMAZONIAN AND ANDEAN COUNTRIES

BRAZIL

Wood harvesting

The quantity of timber extracted is extremely variable and, on average, it would be misleading to give figures higher than 10 m^3/ha for the mobilization of this resource over large areas.

The wood industries are supplied from four major sources:

- the clearance of areas destined for agricultural recovery;
- logging permits for private forests subject to management plans;
- artisanal logging in the Varzea;
- and also illegal and uncontrollable logging, particularly in the classified forests and reserves.

The supply channels followed can be divided into three types:

- directly by the industries themselves, the rarest method: 5 to 10% of wood enterprises;
- through private intermediaries: the commonest system, adopted by three-quarters of wood enterprises;
- a mixture of the previous two for the remainder.

Wood utilization

Brazil is one of the world's largest wood producers, particularly with regard to tropical woods; however, the contribution of its resources to foreign trade is very small.

A very large proportion of the wood harvest is consumed as fuelwood and charcoal (over 175 million m^3/year, 18 of which are from Amazonia), particularly by the iron and steel industry.

In addition, a large portion of the industrial roundwood harvest consists of pit props and poles. Lastly, Brazil produces almost 40 million m^3/year of timber, 53% of which consists of pinewoods, and 29 million m^3 are from the Amazonian regions.

In addition to these wood products, the Amazonian forest supplies many other products of various kinds (foods, medicines, cosmetics).

As regards timber from broadleaved species in log form, Brazil imports 50 000 m^3/year and exports only 10 000 m^3/year.

On the whole, the country consumes by far the greatest part of its products, and external trade, although by no means negligible, only involves a small proportion of its output:

- Its sawmills produce 18 million m^3 of sawn timber, 2.9% of which is exported, and the domestic market also absorbs about 300 000 m^3 of imports.

- Paper-pulping and paper and cardboard manufacture are the two most active and dynamic wood industries after the sawmill sector: they produce 3.9 million tonnes and 4.7 million tonnes respectively. A relatively large proportion of their output is exported (21% and 13% respectively). Small quantities are also imported (40 and 260 000 tonnes/years respectively).

- The heavy industries engaged in wood panel manufacture operate at roughly comparable levels (with very small or non-existent imports).

- Plywoods are the most important of these products: 900 000 m^3/year, 25% of which are exported.

- Particle-boards follow closely in their wake: 660 000 m^3/year with negligible external trade volumes.

- Fibre panels have risen over the last few years to a ceiling level of 750 000 m^3/year, slightly less than a third of which (29%) is exported.

- Lastly, the veneering industry has quite a large output (220 000 m^3/year), 28% of which is exported.

BOLIVIA

In theory, a management plan is necessary to obtain a logging permit, with a cutting schedule based on a detailed preliminary inventory. But in practice, this involves at best a preparatory survey to identify the most advantageous logging sites, and no form of resource renewal is ever contemplated (and what is more, the means to ensure compliance with these plans are lacking).

At present, the duration of logging permits is only one to three years...

The wood industry is composed essentially of:

- small sawmills that process only mara and a few valuable woods, or else produce building timber (using a larger range of species) from logs obtained from areas cleared for land settlement;
- second processing workshops;
- individual operators who cut and saw directly in the forest (often illegally); and
- a very small number of medium-sized enterprises which utilize wood resources in a slightly more integrated fashion.

As has often been remarked, access to this resource is difficult due to the lack of an adequate road network, and timber extraction is necessarily limited to four or five months per year.

Logging is insufficiently or badly organized, large quantities of material are lost at the point or origin or in transit, the sawing yield is low and the processing centres are in most cases too far away from the resource... The cumulative effect of all these problems is the already mentioned decrease in the stock of valuable species that still assure some margin of profit.

- The wood harvest serves above all for fuelwood in this high-altitude rural country: low-income Bolivians, with their closed autarchical economic system, depend very heavily on wood for their domestic fuel supply: approximately 1.2 million m^3 (1.23 in 1987) of wood is harvested each year for this purpose.

About 10% of this volume goes to sawmills (136 000 m^3 in 1987), and 10% of the latter figure gives the roundwood volume.

Less than half (40%) of the sawn timber output (95 000 m^3 in 1987) is consumed locally; the remaining 60% is exported.

Lastly, the one small plywood production unit (with an output of a few thousand m^3/year - 8 000 in 1987) is not quite sufficient to supply the domestic market for this product (about a thousand m^3/year are imported). Around a thousand m^3/year of veneer products are exported.

COLOMBIA

The wood industries in Colombia are characterized chiefly by the very low volume of foreign trade and the limited satisfaction of the still fairly small domestic market.

It is also noted that the mangrove forests have already been overexploited to produce charcoal.

According to the available statistics (FAO - 1987 Yearbook of Forest Products) the production of industrial timber logs has been stagnating for several years at around 2.7 million m^3, whereas it exceeded 3 million m^3 in 1980 (with the already mentioned risks of over-exploitation). There is no foreign trade in this item.

The species exploited are the "Cedro" (*Cedrela odorata* & spp.), the "Mora" (*Chlorophora tinctoria*), the "Abarco" (*Cariniana pyriformis*), the "Roble" (*Tabebuia pentaphylla* and *Terminalia amazonia*), the "Tangaré" (*Carapa guianensis*), several types of "Cangaré" (*Dialianthera gracilipes, D. otoba, D. macrophylla, Virola carinata*), the "Nato" (*Mora* spp.) for pit-props, the "Sajo" (*Campnosperma panamensis*), the "Machare" (*Symphonia globulifera*), the "Cativo" (*Prioria copaifera*), the "Guasco" (*Cordia alliodora*),...

The wood undergoes three types of industrial processing:

- Sawing, which produces sufficient sawn timber for the domestic market (around 720 000 m^3/year), its only customer.

- Panel manufacture (particle-boards, plywoods, fibre-boards), with outputs of around 50 000, 40 000 and 20 000 m^3/year respectively. The plywood industry is declining, whilst the particle-board plants are increasing their output.

- Paper and cardboard production, which has recently been steeply increased (to around 480 000 tonnes/year) to restrict imports (150 000 tonnes/year in 1987).

The products are probably used chiefly as packaging for agricultural produce.

ECUADOR

With a population about half that of neighbouring Peru, Ecuador harvests twice as much timber-wood (economy stimulated by oil resources).

Logging and wood processing, which have developed considerably over the last decade, are both active with potential for futher development:

- The private industrial fabric is dynamic and various, ranging from small hand-run artisanal sawmills (North-West regions,...) to mechanized industrial enterprises such as Plywood Ecuatoriana or Baltek in the cities (the latter manufactures and exports products made of balsa *Ochroma lagopus*).

- The private industrial sector contributes directly or through reforestation companies to the restocking or even, in some cases, the establishment of this resource (forest plantations).

With its 6.3 million m^3 (in 1987), the fuelwood harvest (firewood and charcoal) is almost three times (in volume) greater than the timber harvest (2.3 million m^3) for the same year.

The timber processing industry is diversified, although sawing is heavily predominant:

- The quite vigorous domestic market (building, furnishing, joinery, rural crafts...) is supplied from the local sawmills. Only a small proportion (less than 30 000 m^3) of the sawmills' total output (1.26 million m^3 of sawn timbers in 1987) is exported.

- With a plywood output of 85 000 m^3 and almost equal output of particle-boards (80 000 m^3), the wood panel industries and their domestic market are quite considerable. (Only 15 000 m^3 and 2 000 m^3 respectively are exported).

- A small output of veneer leaves completes the wood industries' range.

The present deficit in the wood sector's balance of trade, as in other countries in this region, is due to paper and cardboard products, as the domestic market's import requirements amount to 10 000 tonnes of paper pulp and over 140 000 tonnes of paper and cardboard (despite the local industry's output of over 50 000 tonnes of these products).

PERU

Wood-harvesting in Peru is heavily dominated by the fuelwood sector (6.5 million m^3 in 1987); industrial logs for non-sawnwood uses account for less than 100 000 m^3/year (93 000 in 1987).

The timber-wood harvest (1.1 million m^3/year in 1987) is destined almost exclusively for processing into sawnwoods (535 000 m^3 produced in 1987) for the domestic market (only 2 000 m^3 were exported), and the supply is supplemented by a small quantity of imports (7 000 m^3 in 1987, reduced by 3.6 over the last ten years).

A very slight portion of the log harvest supplies a small plywood industry (23 000 m^3 produced in 1987, exclusively for the local market) and veneer industry (9 000 m^3 in 1987, of which 1 000 were exported).

Paper-pulp is mainly imported (44 000 tonnes in 1987, as against 1 000 tonnes produced locally in the same year).

The local paper-making industry (163 000 tonnes in 1987) must be supplemented by imports (amounting to one-third of total paper consumption in 1987) to meet the domestic demand.

VENEZUELA

The fuelwood harvest is less extensive in Venezuela, a major oil-producting nation, than in other countries in this region (only about 700 000 m^3/year).

Timber is also not a particularly intensive sector (630 000 m^3 per year on average), and has been stagnating for over ten years.

The wood processing industries produce a wide range of products:

- sawnwoods: 300 to 350 000 m^3 per year;
- particle-boards: about 100 000 m^3 per year;
- plywoods: 40 000 m^3 per year;
- fibre-boards: 18 000 m^3 per year;
- paper-pulp: 8 000 tonnes per year;
- paper and cardboard: about 675 000 tonnes per year.

Their primary object is to supply the domestic market and keep imports as low as possible. Some imports are still a necessity for all these products (except for fibre-boards and particle-boards): over 50 000 m^3/year of sawnwoods, 15 to 20 000 m^3/year of plywoods, 5 000 m^3/year of veneer leaves, 295 000 tonnes of paper pulp, with regard only to 1st processing products.

Imports are also necessary to satisfy the local demand for 2nd processing products. These include nearly 200 000 tonnes of paper and cardboard, and also furniture, etc...

No wood product exports are reported in the statistics collected by FAO.

VI. RESEARCH

Applied research and closed forest management projects are frequently inseparable, as silvicultural programmes for the enhancement of forest stands are only carried out on an experimental basis or on a very small scale in the tropical American countries.

Despite this overlapping of research and development projects, we have attempted in the following pages to focus exclusively on the experimental trials to further technical and scientific knowledge.

1. THE ISTHMUS AND CARIBBEAN COUNTRIES

NICARAGUA, PANAMA, COSTA RICA, HONDURAS, GUATAMALA AND EL SALVADOR

Research has been oriented chiefly towards plantation silviculture or agroforestry.

Natural forest research is confined in most of these six countries to investigation of the composition, nature and potential of the forests and stands, often with a view to logging.

In the absence of a research programme covering the Isthmus countries as a whole, some experimental projects have been conducted on a national scale.

In Guatemala, the research projects undertaken with FAO assistance from the early sixties onwards in the forests of the Peten region have been virtually abandoned.

In Honduras, the ACDI/COHDEFOR trials integrated with management have come to nothing.

In Nicaragua an ecological research project should, in principle, be implemented with Swedish Cooperation (SAREC) aid and with the participation of CATIE and UCA (Universidad Centroamericana), in the heart of the "Parque Internacional" of La Paz in the Rio San Juan moist forest. It covers research on natural regeneration, the phenology of the principal species and the impact of forest exploitation, and also enrichment planting trials for logged compartments.

In Panama only one research project can be mentioned: a study of Cativo (*Prioria copaïfera*) formations, conducted in the seventies.

This alarming situation is explained by lack of government interest, funding and researchers, which the TFAP (TROPICAL FORESTRY ACTION PLAN) measures are seeking to remedy. It must be recalled, moreover, that the Isthmus has major assets in the form of regional organisms such as the IICA and CATIE, whose action in the Forestry Research and Development field must be developed and given international backing.

The CATIE (Centro Agronomico Tropical de Investigación y Enseñanza) is responsible for the only successful natural forest research programme in the region.

This programme is being conducted in Costa Rica, and concerns both secondary forests (at Sarapiqui) and primary forests (at Guapiles). It is based on a network of one-hectare observation and measurement plots to monitor the structure and evolution of diffferent types of stands (and particularly their reconstitution after clear felling 25, 15 and 2 years previously).

These experiments, which commenced in 1985, are beginning to communicate their findings after the three annual measurement campaigns from 1987 to 1989 carried out at Sarapiqui. These findings (Finegan B. and Sabogal C., 1988 and Finegan, 1991) chiefly concern the growth, mortality and new growth of the different species, and also the productivity of 15 and 25 year-old even-aged plantations; they constitute the foundation for the directives issued on the management of the region's secondary forests (see next chapter on forest management).

In addition, the evolution and dynamics of high-altitude stands of oak (*Quercus* spp.) in the Talamanca Cordillera are also being monitored. Lastly, the Tropical Studies Organisation (TSO), composed principally of United States universities and the university of Costa Rica, is conducting fundamental research on the forest ecosystem in the Sarapiqui region (La Selva station), in the Atlantic forest zone.

MEXICO

In the Yucatan peninsula, the forests considered impoverished by selective felling of valuable species have, since the sixties, undergone ineffectual attempts at forest enrichment with Caoba and Cedro rojo by the open strip planting method.

Natural regeneration trials had failed with these two sun-loving species, which require large openings in the forest and have difficulty in coping with competition from herbaceous, shrub and tree regrowth.

Forestry research proper in the tropical zone was commenced in 1968 by INIFAP (Instituto Nacional de Investigaciones Forestales y Agropecuarias), which undertook the first floristic, botanical and wood anatomy studies and also established plantations of Teak (*Tectona grandis*) and *Cedrela odorata*.

Commencing in 1981, a network of 20 permanent one-hectare plots was established in the coastal area of the Gulf of Mexico to study untouched forest ecosystems and their evolution. It has provided much information on their phenological characteristics, seed dissemination and high evergreen forest structure. At the same time, research has also been carried out on the regeneration of *Cedrela odorata*.

The current research projects are oriented towards the study of global forest dynamics, the growth of valuable species and, more particularly, the impact on regeneration of different felling rates at Quintana Roo (Snook L.C., 1991).

BELIZE

Forestry research in Belize is at present following the opposite approach to what would appear optimum: as it is concentrating on plantation silviculture whilst research in closed broadleaved forests (especially those under management plans) is neglected.

It is true that the means and opportunities to apply the findings obtained in broadleaved forests are limited due to the forest ownership structure, ...

It is likely that the archives of the forestry research department contain a wealth of material in this regard which should be more fully exploited.

PUERTO RICO

Forestry research in Puerto Rico can be subdivided into two successive phases:

- From 1920 to 1950, faced with the erosion problem research work was concentrated chiefly on the germination and planting of native and introduced species (100 local species and 350 exotic species).

- From 1950 onwards, more prominence has been given to ecological and botanical research, closely linked to endemism and nature protection problems.

MARTINIQUE AND GUADALOUPE

Research in these two islands has followed a pattern similar to that of Puerto Rico: the majority of trials deal more specifically with plantation silviculture, especially that of Mahogany (*Swietenia* spp.), but some research is also conducted on the natural (assisted) regeneration of some closed forest species, the most important of which is the "Poirier", *Tabebuia palida*.

TRINIDAD AND TOBAGO

Moist forest research began many years ago in Trinidad on an empirical basis, as was the case early in this century in most tropical countries under the "colonial wing".

Trials were carried out with an informal "let's see what happens" approach, without setting up any elaborate experimental procedures (replication, plots, uniform treatments, ...).

In 1956 a trial was conducted in a forest logged in 1942 and subsequently regenerated by the "shelterwood system".

Five treatments were applied with five replications (on one-hectare plots). The differences between silvicultural treatments do not seem very evident in the light of the last analyses in 1987. Except for this localized experimentation in the Arena forest, no other recent research has been attempted with regard to natural forest management.

On the other hand, after the national inventory carried out between 1978 and 1980, a network of 159 permanent and periodically measured plots has been progressively set up in forest stands from 1983 onwards.

Most have been the object of two or three measurement campaigns. It must be emphasized that this network is quite exceptional in tropical America, as a monitoring and decisional tool for forest management programmes.

2. THE GUYANESE REGION COUNTRIES

GUYANA

In direct line with the concepts of "sustainability" and "biodiversity", a major research programme is foreseen in this country: the Guyana Rainforest Sustainability Programme (GRSP).

Its object is to study the changes in forest dynamics and plant-animal relations after the harvesting of various forest products.

This programme is based on procedures, yet to be established, that will allow comparison between the following types of treatment:

- undisturbed control plot,
- selective exploitation for timber,
- harvesting of non-wood produce,
- exploitation plus produce harvesting ...

Each treatment will be repeated three times on very large plots (2 x 2 km, i.e. 400 ha each). Their impact on the ecosystem will be evaluated through the collection of data on the populations of animal and plant species of ecologic and/or notable ecologic importance.

The programme site will be near Kurupukari and will be implemented in the framework of the Tropical Forests Action Plan and the Commonwealth Tropical Sustainable Forestry Programme.

SURINAME

The first silvicultural trials were carried out in 1904, when the Forestry Service was first established. They concerned natural and artificial regeneration, and were abandoned in 1925 when the department was abolished. In 1947, research showed that native species could

attain a diameter of 30 cm in 30 years, but in 1949 the Service directed its efforts towards silviculture in man-made wooded areas.

The Caribbean pine (*Pinus caribaea hondurensis*) was introduced in 1949. It grows well except on the very poor white soils in the forest belt. The young pines are planted after the sites have undergone mechanical clearing, windrowing and burning, at intervals of 3.5 x 2.2 m to 3 x 2.75 m. The tending required until the canopy closes is assured by both mechanical (rotavor) and chemical means.

The pine plantation programme was abandoned in 1978, because of its labour and maintenance costs and the low growth rate of the older plantations due to the soils' poor mineral content.

There are today about 8 000 ha of pines, the majority of which are in a very poor state.

The broadleaved species planted include both indigenous trees:

Virola surinamensis
Simarouba amara
Cedrela odorata

and exotic species:

Cordia alliodora
Eucalyptus spp.
Aucoumea kleineana.

The various species were planted singly or mixed with pines, in strips or in enrichment plantings. In all cases the tending operations, which cannot be mechanized, became prohibitively expensive and the stands, which cover a total of around 3 500 ha, are virtually unproductive.

The pine plantations are very costly (US$ 1 000 per ha in 1973). The two major expenditure items are mechanical clearing and tending. Their cost has been constantly increasing, whilst production has proved lower than had been foreseen (11 m^3/ha/year instead of 13 m^3/ha/year). As the energy cost has been rising steadily since 1973, pine regeneration has consequently been abandoned.

Enrichment with broadleaved species requires lengthy and careful tending for some fifteen years; the cost per hectare consequently amounted to about US$ 1 000 in 1978, and this led to the abandonment of this technique at the end of the seventies.

Natural regeneration: Silvicultural trials conducted in the fifties and sixties involved poisoning off undesirable species and creeper removal. The initial response of the main species was good (diameter increment of 1 cm per year), but the regrowth was very vigorous and required excessively costly work to save the future stock. The single-cycle system was thus too energetic at the start.

Analysis led to the proposal of a multi-cycle system with three thinnings: the first immediately after exploitation, then another eight years afterwards, the last 16 years later, and a second harvest 20 years after the first. The intensity of the thinnings depends on the final basal area desired and thus requires a preliminary inventory.

In 1976, trials conducted over 25 ha showed satisfactory growth rates (1 cm/year in diameter) and reasonable costs.

This technique, named the CELOS Silvicultural System (CSS), gave rise to new logging techniques in the CELOS Harvesting System (CHS). The CELOS system is described in detail in the CASE STUDY.

FRENCH GUIANA

The silvicultural trials carried out in French Guiana have successively followed three different research approaches.

In the fifties, a first study project on the regeneration conditions of timber species was begun, based on:

- observation plots to monitor the effects of logging on the balance of the tree population;

- plantations on small areas, either in strips or over the full site after manual clearance. Both indigenous species (*Angelica, Carapa, Cedrela, ...*) and exotic species (Teak, *Swietenia*, Caribbean Pine) were used.

The native species subsequently proved a total failure, and of the exotics, only *Pinus caribaea* gave valid results (15 to 21 m^3/ha/year at the age of 6 years).

In 1975, industrial projects for paper-pulp plants foresaw the total utilization, in the initial phase, of the primary forest species over large areas (15 000 ha/year). The subsequent cycles were to be provided for by fast-growing exotic species, as natural regrowth produces few species of sufficient density.

The trials, conducted by the ONF and above all the CTFT, had two priority objectives:

- to discover suitable species and provenances, or create hybrids to produce the greatest possible amount of high-density wood;

- to perfect silvicultural techniques that would assure maximum yields under economical conditions.

The species tested were: *Pinus caribaea, Eucalyptus urophylla, Acacia mangium, A. auriculiformis*, etc.

In a wider perspective, it is evident that the only efficacious silvicultural techniques are those that do not expose the soil, but in this case the work necessary to establish and tend the plantation cannot be done by mechanical means, and when labour expenses are taken into account the cost prices become prohibitive.

None of the species tested could provide a high enough yield to make the reforestation of large areas a profitable enterprise.

Consequently, in the early 1980s, silvicultural research began to concentrate on the evolution of natural stands after logging, and thus on the improvement techniques described in the CASE STUDY on the PARACOU SITE.

3. THE AMAZONIAN AND ANDEAN COUNTRIES

BRAZIL

Silvicultural research projects are conducted both by the official research agencies and by major companies that own large mines and vast tracts of forested land.

Two types of silvicultural approach can be distinguished:

- multi-cycle silviculture focused on timber harvesting;

- a far more radical type of silviculture based on both timber and fuelwood harvesting. All these projects are concentrated in the upland closed forests.

Multi-cycle silviculture research is conducted by:

- EMBRAPA in the Tapajos national forest area;
- INPA near Manaus
- SUDAM and FCAP at Curua-Una (see CASE STUDIES on these three experimental programmes).

The operations required are defined in terms of more or less intensive harvesting involving removal of from 15 to 35% of the basal area for trees of exploitable diameter on the Tapajos sites and from 30 to 40% of the basal area at Manaus on the INPA plots.

Data is collected on growth by diameter classes, on the amount of regeneration, and on both natural mortality and that due to exploitation damage.

Silvicultural trials by mining companies: the mining companies are large consumers of fuelwood or charcoal. Hence, in addition to timber, they are also interested in harvesting the lower storeys.

Florestas Rio Doce (FDR), a subsidiary company of CVRD and Mineraçao Rio do Norte, is the most active with five sites:

Sites	State	Type of forest	Area
Linhares	Espiritu Santo	Atlantic coastal forest	20 000 ha
Buriticupu	Maranhao	Moist upland forest	10 000 ha
Maraba	Para	" "	17 000 ha
Açailandia	Para	" "	2 000 ha
Combretas	Para	" "	--

The types of treatment received can be subdivided into three classes:

- no logging, control plot with monitored growth rates and forest dynamics;
- clear felling and single-cycle harvesting that can evolve, if an appropriate harvesting schedule is foreseen, into "coppicing" for fuelwood uses;
- harvesting of both large-diameter wood (timber) and small diameter wood (fuelwood). A variable amount of medium-diameter stock is left standing so that the stand can develop into a "coppice-with-standards" in which the upper storey is harvested for timber and the lower one for fuelwood.

In all these cases, creepers are systematically cut and, in the coastal forest, leaf-litter removed to allow regeneration to become established.

The first findings indicate that the regeneration is very vigorous and enrichment by planting is unnecessary and costly.

The very existence of these very enterprising trials is an extremely positive development, but a wider perspective is indispensable before these methods can be proposed for large-scale use.

COLOMBIA

The principal research programme for forest management in Colombia was conducted between 1975 and 1980 in the framework of an FAO/UNDP/INDERENA Project which aimed to establish a favourable context for experimental plantation and natural forest silviculture initiatives all along the coastal fringe, in the most vulnerable area of the country.

The various initiatives undertaken in the framework of this Project came up against all kinds of technical, administrative and logistic difficulties, and after four or five years' work most of the trials were left unfinished or had barely begun, and consequently the findings were partial or provisional for lack of medium-term follow-up.

Nonetheless, in the case of natural forest, a good knowledge of the environment and the existing ecosystems was obtained, and although the findings with regard to heterogeneous closed forest were insufficient (the clear felling or selective exploitation trials were barely commenced), it was possible to draw up technical recommendations for the Guandal and Cativa forests.

The Guandal (described previously), in which *Dialyanthera gracilipes* and *Campnosperma panamensis* are the two predominant species, covered about half a million hectares in the 1970s. This type of forest is very dynamic and regenerates well: it is necessary to ensure that felling does not exceed 60% of the exploitable stock so as to leave enough seed-bearers, and then to carry out thinnings on a selective basis in the upper storey and to thin out the lower storey (early on and removing less than 40% of the stems) in order to improve the stand's quality and reduce competition for growth. Lastly, care must be taken not to alter these slow-draining soils during harvesting operations, so as to avoid drying detrimental to the dynamics of the forest ecosystem.

In the case of Cativa forest, the excessive opening-up of traditional logging definitively prevents the regeneration of the valuable species, whose seedlings require some shelter for their initial growth.

It was thus necessary to reconsider the manner in which timber harvesting is to be conducted, by decreasing its intensity and/or applying alternate strip methods... but these aspects still remain to be defined, specified and tested by experimentation.

A research operation in coastal forest is underway in the BAJO CALIMA concession held by the firm SMURFIT CARTON DE COLOMBIA.

Some thirty plots measuring 0.1 hectares each have been set up in the compartments clear-felled by this paper-manufacturing company since 1974. The measurements and observations are similar to those carried out in Costa Rica, and aim to determine the modalities of natural forest reconstitution and foresee the felling cycle for durable exploitation (Faber - Langendoen, 1990).

After twelve years, the findings show that 46% of the original basal area and 36% of the biological diversity of species have been attained; but the regeneration consists largely of pioneering or colonizing species and, even after thirty years, would still be far from reconstituting the floristic composition of the so-called "climax" forest.

It would take at least 60 years to restore the stand to a state resembling that existing before it was logged.

Two exploitation models have thus been envisaged, with felling cycles of 30 and 60 years respectively, it being imperative in both cases to keep the forest around the logged sectors untouched so as to assure enough seed stock for the regeneration of mature or climax forest species.

Note: this initiative is not receiving any external (financial) aid.

ECUADOR

- Esmeraldas Project

Most of the closed forest research work has been carried out in the framework of international projects, the most important of which, in terms of both results and seniority, is the five-year FAO forestry development project at ESMERALDAS in the Noroccidente Region (see Manejo Forestal final report, R.G. Dixon, 1971).

In addition to pure or enrichment plantation trials with local or introduced species, a study (from 1965 to 1966) was conducted on the effects on the dynamics of natural regeneration of various types of silvicultural treatment:

- felling of all trees of over 15 cm diameter (as in paper pulp exploitation);

- traditional timber exploitation with two thinning rates concerning non-marketable species (by devitalization, leaving the tree standing).

In spite of the short time-scale, it was possible to ascertain, two years after treatment, that heavy felling (paper-pulp model) gave rise to an explosive proliferation of the colonizing species most often found in artificially cleared areas: *Cecropia, Ochroma, Vismia* and *Trichosperma*; and that the reconstitution of the valuable stock will only occur over a long period (the useful species should be freed from encroaching plants to speed up their growth).

The areas that had received treatments combining traditional logging plus thinnings underwent measurement and observation after a one-year interval: regeneration was found to be more harmonious (no radical floristic differences as compared to the untouched compartment) in spite of the large-scale disappearance (55%) of the pre-existing regeneration plants and seedlings, due to the exploitation of the upper storey.

Due to lack of long-term follow-up and interest on the part of the authorities, this research programme failed to provide the expected data.

- Plantation silviculture

After this first series of trials concerning the dynamics of natural forest stands, research priorities were totally diverted to plantation silviculture. Today Ecuador is a country that aims towards "effective" reforestation; the main species used are: *Cordia alliodora, Tectona grandis, Pinus radiata, Pinus patula, Eucalyptus globulus, Ochroma*

lagopus and *Schizolobium parahyba*. The latter species (the Pachao) is expected to have a "great future", as it grows well in plantations, with an excellent yield, and it supplies a good wood for peeling.

The plantations have so far been established on small, very scattered manually cleared sites. The implementation of large-scale planting campaigns will therefore require the development of techniques that are not yet well-known or adequately tested in Ecuador.

PERU

Until recently, the forest plantations were concentrated in heavily populated zones with degraded forest cover, i.e. in the Andes and on the coast.

The first trials concerning the artificial regeneration of closed forest utilized fast-growing, local or imported species. The principal species used were:

- *Cedrelinga catenaeformis*
- *Swietenia macrophylla*
- *Clarisia racemosa*
- *Tectona grandis*
- *Terminalia* spp.
- *Simarouba amara*

However, these plantations never covered any large areas:

Forestry research in closed forest began in 1942 at the Tingo Maria experimental station, which later became the Universidad agraria de la jungla de Tingo Maria. The principal parties engaged in research activities include:

- The Agrarian Bank, at Yura,
- The La Molina Faculty of Forestry,
- The school for forestry technicians at Iquitos,
- The national faculty of forestry,
- The FAO management project for A. von Humboldt National Forest (CASE STUDY)
- The Institute for Research and Development of the Amazon (IIAP) at Iquitos.

The trials conducted are numerous, but they lack coordination and are concentrated essentially on fast-growing reforestation species for timber production.

Recent trials on the atural regeneration of tropical forest have been conducted under the Palcazu project, and are described in detail in the CASE STUDY.

The IIAP is conducting an original research programme to promote the production of food and services by the forest. Its chief features are:

- inventory of species and ecosystems,
- study of fruit-bearing forest trees.
- socio-economic study of local palms;
- utilization of the Aguaje (*Mauritia flexuosa*)
- utilization and conservatiuon of phytogenetic resources.

VENEZUELA

The first large-scale forestry research in Venezuela involved plantation silviculture at research stations such as Caparo or Ticoporo (already mentioned); it gave rise to some large plantation schemes utilizing fast-growing species, and particularly *Pinus caribaea*.

In 1988 the plantations covered a total area of around 257 000 ha, 124 000 of which were planted by CONARE, about 100 000 by CVG (Corporación Venezolana de Guayana) and the rest by various mixed or private enterprises.

Natural forest research was initially conducted "statically" to study the undisturbed forest ecosystem (structure, botany, ...) and has only recently extended to natural regeneration trials in the forests of Ticoporo, San Pedro and Imataca, based on clear-felling treatments in long narrow strips (10, 30 or 40 m wide), in the same spirit as the trials carried out at Palcazu in Peru.

The findings are not yet available, but it is already recognized that this silvicultural approach is feasible only when all the wood stock can be put to use (for instance, to make charcoal).

In addition, trials are being conducted on the same sites with a view to improving the regeneration patterns of forests selectively exploited for timber. They foresee creeper removal, weeding and standing devitalization of excess trees with no commercial future.

These silviculture operations appear to be the most effective, but their number and intensity must be proportioned in relation to various constraints concerning not only costs but also, and above all, the pragmatic possibilities of large-scale implementation.

Note: The chief problem posed by these experimental trials is unquestionably the difficulty of ensuring rigorous long-term follow-up.

4. OVERALL SUMMARY OF RESEARCH

In many countries, little or no research has been conducted on how the forest ecosystem functions and its dynamics in relation to human or silvicultural intervention.

In Central America, the only experimentation on these themes is that carried out by CATIE in Costa Rica in secondary forest and high-altitude stands of oak.

The secondary forest trials gave rise to two management options, one leading up to clear felling after about fifty years (with two intermediate cuts) and the other foreseeing partial exploitation by 20-year rotation (with thinning of secondary species).

Some other countries in this region have attempted such trials, but often without adequate follow-up. In Puerto Rico, however, some silvicultural rules are being applied in secondary forest based on estimated standing timber volume in the dominant storey. The research on regeneration in the logged-over closed forests of the Amazonian and Guyanese regions has been based on two approaches:

- regeneration of the lower storey consisting of seedlings and small trees in relation to the total or partial opening-up of the canopy (upper storey), accompanied by silvicultural operations (creeper cutting, freeing from encroaching plants, ...) in favour of the valuable species;

- and monitoring the growth of the medium, large or small trees in the upper storey, in relation to more or less intensive extraction schemes (different exploitable diameters for timber, or types of utilization such as fuelwood), with thinning of the upper storey to enhance its quality by removing unusable secondary species.

The regeneration trial findings can be very briefly summarized as follows:

- the clear felling of alternate strips of forest, as carried out at Imataca and Ticoporo in Venezuela or at an earlier date in Ecuador, resulted in only slight improvement, as it involves destructive exploitation that is only justified when all the original stock is recuperable, and gives rise to poorly stocked secondary bush of greatly reduced biological diversity;

- the partial opening-up of the canopy by various procedures does redynamize regeneration at ground level, but the effectiveness of freeing saplings and valuable stems from weeds and competitors is not always proved, except in the case of the Arena project in Trinidad, which certainly shows the effectiveness of the shelterwood system, but also the high costs involved.

Most of the trials which investigate the effects of more or less intensive logging, with or without improvement thinnings, have been conducted in Suriname, Brazil and French Guiana.

In Suriname, the CELOS programme has developed a 20-year multi-cycle system with partial logging and three successive thinnings of secondary species. Trials have also been conducted to define a less destructive logging system.

In Brazil, trials such as those conducted at TAPAJOS, for example, confirm the previous finding: trees react positively to the opening-up of the canopy, at least in terms of diameter increments.

The more recent trials conducted by INPA at Manaus and PARACOU in Guyana are beginning to produce their first quantified results after silvicultural treatments, which tally in all cases with those previously reported; this has given rise to an initial series of pilot management schemes that apply the recommended thinning techniques after timber harvesting.

In conclusion, the cumulative findings obtained in a piecemeal fashion here and there, would constitute a precious source of silvicultural information, if properly updated; a detailed critical study grouping all this experimental data would certainly be a massive task, but should be included amongst our present priorities. It would make it possible to consolidate forestry development projects and avoid repeating unnecessary and costly operations that often have no hope of success.

VII. MANAGEMENT PROGRAMMES AND PROJECTS

1. OVERVIEW

Before discussing forest management in tropical America, it seems opportune to quote from R. SCHMIDT's introduction to the subject in his article entitled "Tropical Rain Forest Management: A Status Report", published in issue 156 of "Unasylva" (1987):

> *"There are currently no large-scale sustained yield management programmes being implemented in the vast closed broad-leaved forests of tropical America. This is certainly not for lack of resources: in 1985, tropical America had an estimated 491.8 million ha. of productive closed broadleaved forests, of which 54.7 million ha have been logged over. The current absence of this type of management is certainly not because of lack of experimentation, recommendations and attempts at pilot demonstration programmes even though more effective efforts need to be conceived and designed."*

In addition, looking at the 1988 study commissioned by ITFO (International Tropical Forest Organization), in particular the document entitled "No Timber Without Trees": Sustainability in the Tropical Forest" (D. POORE, 1989), we find T. SYNNOT, author of the chapter on South America and the caribbean, summing up the situation in no uncertain terms:

> *"However, from the viewpoint of professional forestry, this consultant has not identified any case of operational TMF management for sustainable timber production in any member country except Trinidad and Tobago. Even in Trinidad, management is not intensive, but it fulfils the criteria, although silvicultural treatments are rarely applied and management plan prescriptions are not followed in strictest detail. In other countries, in spite of striking advances during the past ten years or more, the following components are generally weak or lacking: advance planning of the location and intensity of the annual cut supervision and control to ensure that the cutting follows the planning; and protection of the area to limit unplanned activities including settlement and uncontrolled logging."*

This (partial) conclusion was the outcome of the author's 1988 study of forest management (in the conventional sense of the term) in the rainforests of Brazil, Bolivia, Ecuador, Honduras, Peru, and Trinidad and Tobago.

All things considered, it appears that although applied research projects are not numerous in proportion to the entity of the problems posed by the forest ecosystem and its degradation/destruction, the technical tools needed to establish sustained management systems are indeed available.

Given the importance of the deforestation problem in most of the tropical American countries, one approach to its solution, or at least mitigation, is through direct governmental intervention. A more recent approach is to delegate forest management to the landowners, concessionaires or local communities entitled to use this resource.

In effect, the real problem is posed by human constraints, which can be summed up in a question: What is forest management supposed to achieve?

Experience shows that it is unnreasonable to entrust forest management to any one entity: goverment agency, private sector or the rural population.

This accounts for the emergence today of community management projects, where the local population undertakes to manage the forest ecosystem with government support; technical and financial aid from international organizations, non-governmental organizations and bilateral cooperation agencies; and assistance from research and development centres.

Among all the community actions conducted by local populations, we may mention three which directly concern the use and improvement of natural forest stands:

- Mexico's Quintana Roo Pilot Forestry Project (one of the case studies presented in this document);
- the Forest Cooperatives formed in Brazil and Peru (the best known being the one set up in the Palcazu Valley, also presented among our case studies), and most recently in Costa Rica;
- the reserves established in Brazil (notably in Acre State) for long-term production of rubber and Brazil nuts, and in Honduras for the production of pine resin.

These operations take due account of such frequently repeated recommendations as:

(a) To curtail deforestation, the first step is to develop and implement a general land management policy (not limited to forests).
(b) To stimulate the rural community's participation in projects aimed at enhancing and utilizing forest resources, and provide adequate training.
(c) To ensure proper coordination among the organizations and institutions involved in forest management (giving them the resources to apply their policies).
(d) To organize and orient farming practiced in the vicinity of forests (a determining factor for the welfare of the forest itself).
(e) To intensify the silvicultural research (practical even more than scientific) which can supply the information needed to develop sound forest management plans (also considering experience gained in foreign countries).
(f) To carefully analyse the marketing and utilization networks for unprocessed products, in order to develop the resource to the best advantage (reduction of material losses, diversification of species, etc).
(g) To implement a real training effort at all levels, not overlooking the environmental aspect.

2. THE ISTHMUS AND CARIBBEAN COUNTRIES: NICARAGUA, EL SALVADOR, GUATEMALA, HONDURAS, PANAMA, COSTA RICA

The forests of Central America undergo no silvicultural treatment, only selective removal of timber and fuelwood.

This is the result not only of the financial situation outlined earlier, but also of relatively timid legislation that merely requires logging (not mangement) plans to include estimates of production potential and felling rates. Moreover, there is a great lack of competent local personnel and suitable equipment, notwithstanding all the efforts of the international organization, whose short- or medium-term incentive projects are rarely followed up after their conclusion.

At present, the only attempt at silvicultural mangement of a rainforest is the project on second-growth forests being conducted by CATIE (Centro Agronómico Tropical de Investigación y Enseñanza). It involves abandoned lands, formerly farmed and/or grazed, where even-aged first-generation tree stands have developed spontaneously.

Two different regimes are envisaged:

- The mono-cyclic system, in view of producing fuelwood, rural construction wood, and possibly timber. Under this plan, the trees are clear-felled at age 40 to 55 (depending on stand dynamics and site quality), after two thinnings (at age 16 and age 28-32), to improve the growth of the final stand.

After final felling, the plan provides for management of the existing regeneration.

This system is being developed on an experimental basis, and naturally has not been widely applied; nonetheless, it is already apparent that it would be easy to promote in a context where reduction of the Isthmus countries' forest potential will render even intermediate thinnings cost-effective.

- The poly-cyclic system, applied in the highest quality stands to benefit a number of merchantable timber species. For instance, in a 180-hectare forest around 40 years old, it is proposed, after the first ten years, to successively fell all trees with diameters of 50 cm or more; and to designate 20 or so plots corresponding to a 20-year logging cycle. As each plot comes up in turn for the annual coupe, all the high grade trees at least 40 cm in diameter are cut, and the unsaleable trees of secondary species, which would otherwise compete with the remaining valuable trees, are partially eliminated.

From the economic standpoint, this system should be perfectly viable if wood processing facilities are located nearby (shipping costs being one of the major factors working against the rational management of timber products).

In effect, it should be pointed out that the success of forest management according to the techniques outlined above depends on the promotion (and financial support) of small wood-processing enterprises located near the source of raw-material supply.

This development model seems to be the only valid one for most tropical regions seeking self-sufficiency, especially in Central America (whatever the advocates of mammoth industrial projects or hard-currency-earning exports may think).

In conclusion, what is mainly at stake in the Isthmus countries' forest policies is the ongoing development of utilizable (or currently utilized) natural forests. The entity of this stake is considerable, for it involves forest areas that can (still) be counted in millions of hectares, and whose destruction translates not only into environmental imbalance, but also into a loss of potential wood production, aggravated by the disappearance of the production system.

Integral conservation has proved inadequate to preserve the forest patrimony, and it is now admitted that the permanance of the forest ecosystem can be assured only if it becomes the object of development and permanent activity in the field. In other words, only production forests are respected in the long run: those in which the local population has an immediate interest, and whose ownership is clearly established.

In Guatemala, for instance, the rural people have protected the Totonicapan forests because of the benefits they provide (T. Veblen, 1978); the same can be said for the Maria Tecum Forest, which belongs to an enlightened and respected municipality (G. Budowsky, 1982).

Some new programmes that integrate populations and multiple uses of the forest ecosystem have recently been established with international and national aid; among them are the projects undertaken by the FECAFOR cooperative and the GUINOPE programme is Honduras, and the COSEFORMA, BOSCOSA and ASACODE/ANAI projects in Costa Rica.

MEXICO

The concept of forest managment plans has been established to some degree, with the empirical principles of overall estimation of stand growth in preparation for poly-cyclic felling systems (every 20 and 30 years).

These systems have not produced the expected results. At present, Mexico's forest management plans merely establish annual felling units.

Protected areas fall into five categories:

- National parks (at least 1 000 ha).
- National monuments (less than 1 000 ha).
- Ecological reserves, partially affected by human action.
- Biosphere reserves, established pursuant to Unesco's Man and Biosphere Programme; one example is "Montes Azules," created in 1978.
- Recreational parks, located near cities.

In the tropical regions, the proportion of protected areas is presently around 9 percent but should soon increase to 28 percent.

The National Forest Commission (CONAFOR) gives priority to large projects conducted by citizens' groups: EJIDOS (rural communities) in the States of Vera Cruz, Tabasco, Oaxaca and Chiapas, and above all Quintana Roo, to implement Mexico's Tropical Forestry Action Plan.

In parallel, the "Declaración de Tecpan de Galeana sobre los bosques y selvas de Mexico" (published in "La Jornada" in June of 1988) presents the forestry activities of over twenty peasant organizations and draws attention to the importance of their participation in the management and supervision of Mexico's forests.

One well-know and internationally-supported example is the Quintana Roo Pilot Forest Plan, which is conducted for any by the local population (ejido members working communal lands).

The Quintana Roo project is described in detail among the case studies presented in section VIII.

BELIZE

In the natural broadleaved forest, logging rules provide for a minimum felling diameter but are incomplete: logging is not monitored to safeguard the younger trees, minimum logging diameters seem not to have been rationally defined in view of establishing a regeneration cycle, and it does not appear that a sufficient number of high grade saplings are left after felling.

In the natural pine forests, poly-cyclic felling at minimum diameters is inappropriate because the species are light-demanding. Here clear felling would be better, provided nurseries are maintained and fires are effectively controlled to encourage regeneration.

Forest services have an important role to play in this domain, but numerous requirements must be met: accurate inventories, knowledge of annual growth rates, determination of appropriate methods (logging cycle, rational diameter limits, etc.) and forest administration (licensing, record-keeping, controls, etc.) geared to these methods.

To our knowledge, only one attempt at forest management is presently under way in Belize.

It is being conducted in the framework of the "Programme for Belize", and involves conservation and management of the Rio Bravo forest in the northwestern part of the country.

Until recently, the forest was logged by the Belize Estate and Produce Company; Mahogany and Cedar are the major high grade species. In 1988, The Programme for Belize, a non-profit organization, received a government mandate to manage part of the forest (120 000 ha). The Rio Bravo site was to become an important area for conserving and managing the country's natural resources.

In the main, this is a subtropical broadleaved forest growing on a loamy substrate. Stand composition and structure varies widely, and wildife diversity is high (for instance, the forest is frequented by 367 species of birds). Human activities are numerous in the peripheral areas: shifting cultivation highly selective logging, plantation of fast-growing species, and so forth. Numerous Mayan archaelogical sites have also been discovered in the area.

Against this background, the Rio Bravo project was intended to promote permanent economic development and lasting conservation. Theoretically, revenues from sustained forest utilization, harvest of various products and tourism are therefore supposed to cover management, research and training expenses.

How does this actually work out? According to the latest information on the project (see bibliography), the resource inventory is inpreparation and management goals have been defined as follows:

- maintenance of subsistance farming to retain the local population;
- intensive and supervised logging based on a preliminary inventory;
- extraction of non-wood products (chicle in particular):
- preservation of total reserve areas;
- establishment of an ecological research station;
- archaeological excavations;
- development of ecotourism.

At present there are numerous obstacles to implementing a management plan of this kind, but also ways to overcome them. For instance, government grants of property rights outside the area can curtail encroachment. More generally, the presence of project activities in the forest (inventories, tourism, research) will make it possible to keep down illegal activities.

But the two main obstacles are the lack of understanding on the part of the public of some government officials concerning the "freezing" of land and the threart of population growth or foreign investors intentions. Efforts must therefore be made to increase public awareness of the importance of the Rio Bravo project, and its place in national land management must be constantly emphasized in political circles.

PUERTO RICO

The country's forestry management plans are based on two guiding principles:

- Achieving self-sufficiency in food requires working around 350 000 ha of farmland with modern production techniques. Infrastructure and urban areas occupy 120 000 ha.

- It is estimated that 445 000 ha should be left wooded, on account of their slope (> 40 %) or to protect watercourses and reservoirs.

Accordingly, about half of the island's area has an established role as forestland earmarked for conservation and production.

220 000 ha are characterized by difficult features (slopes, lack of water, etc.), so their functions must be limited to conservation and recreation. In fact, insularity has led to a very pronounced endemism affecting both flora (13 endangered species and 22 threatened with extinction) and fauna (especially birds).

200 000 ha of farmer farmland are clearly more suited to forest, but considering the small quantity of standing timber, the only conceivable forest economy at this time is fuelwood and construction wood.

The forest inventory indicates small volumes per hectare and difficult logging conditions. Standing volumes in second-growth forests must therefore be increased by means of cost-effective techniques.

An estimation of standing volume in the dominant storey makes it possible to define a number of possible actions:

- if the standing volume is sufficient, thinning promotes the growth of final crop trees. Considering the ratio between crown and bole diameters, 4 trees per 20 x 20 m section is thought adequate.

- if the standing volume is insufficient, the understorey must be assessed depending on its quality, one of two lines of action should be taken:

. if abundant, cleaning and subsequent thinning;
. if insufficient, either complete reforesting, line enrichment, or limited intervention pending natural regeneration.

A private enterprise was launched on the eastern coast in 1987 with a 12 to 15 000 ha concession for the purpose of supplying royal mahogany (*Carapa hondurensis*) for the production of quality products; the felling cycle is expected to be 15 years.

MARTINIQUE AND GUADALOUPE

These two islands have the benefit of a well-structured Forest Service, much trimmer than in other Caribbean islands.

Forest management began in 1920 with the creation of this service, In Martinique, the 10 000 hectares of State-owned forest (Piton du Carbet and de la Pelée) are grouped as follows:

- Biological reserves, representing more than a third of the total area (created to protect the environment, flora and fauna).

- Production forests: 1 500 ha of mahogany plantations operated for the sale of standing timber.

- Intermediate forests: 500 to 1 000 ha of low grade stands enriched with indigenous species.

- Protection forests, playing an erosion control role on fragile soils and steep slopes: around 3 000 ha plus 2 000 ha of mangroves.

Moreover, privately-owned forests are subject to regulations on clearance for farming.

As in continental countries such as Costa Rica, very significant efforts are made to promote ecotourism in the forests and their recreational role.

The same principles and actions apply in Guadeloupe. Here forests occupy somewhat more land than in Martinique: the State-owned forest amounts to 30 000 hectares, with 5 000 ha of mangroves and around 4 000 ha of mahogany plantations. Guadeloupe's National Park covers most of these woodlands.

TRINIDAD AND TOBAGO

Of all the tropical American countries, Trinidad has the oldest forestry tradition and one of the best and most experienced Forest Services. In addition, it is the only one of these countries which practices sustained forest management in the conventional sense of the term (T. SYNNOT, 1988), despite the failings mentioned at the beginning of this chapter.

In fact, around 75 000 hectares of forestland are currently under management: a significant part of the country's productive forests. 16 000 ha of these forests are considered completely regenerated after logging, thanks to the application of various silvicultural management systems: the open range or selection system, the periodic block system with silvicultural marking, and their variants; and the shelterwood system (no longer in use).

The first forest management projects were designed in 1935, but silvicultural techniques have changed and foest managers have enjoyed a wide latitude of choice. Management techniques have been regularly modified and adapted to specific contexts; they may be briefly described as follows:

- Open range system: since the 1920s, this has been the one most widely applied to control logging operations, and it is still used in certain production forests. Under this system, permits are granted to fell a limited volume and number of trees in areas specified by the Forest Service; the Service controls the selective logging in relation to the potential of final crop trees. Monitoring and control are not always conducted systematically, and in poorer areas the system sometimes leads to the forest's definitive depletion, and eventual conversion to plantations.

In an improved version, blocks are created in order to distribute logging impact more evenly. The open range system within blocks has been applied in northern Trinidad's Mora forest since 1948.

Periodic block system with silvicultural marking: This model is more intensive than the open range system, and puts true silviculture into effect. The Forest Service designates (or marks) all of the trees it believes should be felled in order to maintain a satisfactory forest structure (adequate distribution of final crop trees and seedbearers), culling defective and low grade trees. This system was launched in 1976, but is not really effective because it has proved very difficult to persuade concessionaires to make the effort to cut worthless trees.

The system has lately been improved with compulsory felling incentivated by tax benefits.

This is the model presently recommended, with felling cycles of 25 to 30 years. Stand yields are expected to be lower than under the shelterwood system (which is no longer applied) but higher than the 1 m^3/ha/year estimated for the open range system.

Shelterwood system: This system, wll known throughout the tropics, is described here only briefly because it was applied to fewer than 3 000 hectares before being abandoned in 1978, due mainly to the dramatic decline of demand for charcoal after 1950.

Over the three years of treatment (climber cutting, logging, marking trees for culling), much of the lower and upper storeys was removed by charcoal producers, making these operations easy and inexpensive (in fact, the system largely depended on their contribution).

The most important instance of the application of this system was in the Arena forest, starting in 1929. Devitalization (by poisoning) was gradually intensified as it became more and more difficult to ensure cutting for charcoal.

3. THE GUYANESE SHIELD COUNTRIES

SURINAME

Since 1960, the Forest Service has been doing its best, with the aid of FAO and UNDP, to manage the country's forests scientifically. But at the government level, there is no legislative support for this effort, and the Service can pursue its goals only through agreements with other government agencies.

Forest management in Suriname has gone through four stages:

- before the Second World War, local forestry was influenced by projects conducted by the Dutch in a highly populated region of Indonesia. Industrial plantations were encouraged, and the natural forest was left unmanaged.

- following the establishment of a wood processing industry and the opening of access tracks, the highest grade trees in the forest were skimmed off. Concern about future harvests led to significant contributions of foreign aid for reforestation programmes.

- the plantations proved to be less productive and more costly than expected. Most important, they did not fill the same ecological role as the natural forest. A return to use of natural forests became imperative.

- two options were open. The first was to go back to the forests whose best trees had been skimmed off and harvest the small amount of wood available once again, the second was to develop a silviculture that would enable sustained production.

The second option was chosen, and through a considerable research effort, Suriname developed its Celos Management System, described among the case studies presented in section VIII.

Because of the events that occurred in this country in 1983, the system is not widely applied today, and it appears that the research compartments have not been monitored since 1986.

In fact, only the pine plantations have been managed, and concessions are subject to basic management rules:

- Division into units of 200 to 300 ha and design of a road network.
- Logging quotas, but no penalties for abandoning logs in the forest.
- Supervision by forestry officers, but limited to inspection timber yards.
- Data gathering in view of further silvicultural treatments, but no obligation for concessionaires to apply them.

Forests reserved for future logging are marked out on maps, but are handicapped by their distance and small quantity of standing stock.

Nine natural reserves and national parks cover 570 000 ha, and ten more reserves are planned. Pursuant to the Hunting Ordinance of 1954, these units are managed by the Forest Service.

FRENCH GUYANA

Despite the shelving of paper-production projects and the generally prohibitive cost of plantations in tropical rainforests, the concept of forest management is still evolving in the Republic of Guyana. Local forestry organizations lean more towards applying silviculture to natural stands after logging than radically transforming them. (Demographic pressure is relatively modest.)

Timber production in Guyana is mainly limited to the coastal areas. Only the largest trees of merchantable species are harvested, in the proportion of 7 to 15 m^3/ha for a total biomass on the order of 350 m^3/ha.

As to forest management, at present the National Forest Bureau (Office National des Forêts, the agency charged with managing the Guyanese forest) is directing its activities towards the implementation of management plans in the coastal forests (slightly over a million hectares), in order to establish logging there. This policy rests on the following facts:

- annual fellings are made over an area of 10 000 hectares, and the overall return on investment decreases sharply as crews have to travel further and further inland;

- there is an evident depletion of high-grade species to the benefit of unsaleable secondary species (reduction of botanical diversity);

- research stations (of which Paracou, described below among the case studies, is the most important) are beginning to supply findings to help define a silvicultural method enabling sustained timber prodution in the natural forest.

Accordingly, in 1983 the National Forest Bureau undertook a development project funded by the Guyana Regional council. The project consists of managing two pilot forests:

- Risquetout: 4 500 ha located near Macouria
- Organabo: 13 000 ha located near St. Laurent du Maroni.

The silviculture envisaged in this project will require only limited financial inputs. After the merchantable trees are harvested, around 400 ha a year will be thinned by devitalizing the unsaleable species.

The financial inputs needed to implement this silviculture will be carefully planned and the methods of intervention refined to enable their application to larger areas, closer in size to the 10 000 ha involved in annual coupes. This low-cost silviculture should promote the growth of average trees of currently or potentially merchantable species, enabling a return to logging in the coastal forests after 30 to 50 years' time.

The National Forest Bureau is cooperating with its reseach partners (INRA and CTFT) to obtain the maximum amount of information from these pilot projects. Permanent control plots will be set up in the pilot forests to assess the impact of the silvicultural treatments and test the effectiveness and applicability of research findings on a larger scale.

Lastly, the Bureau has scheduled a management programme for 1992-94 covering 21 forests for a total of around 105 000 ha.

The programme will be applied to 15 000 ha in 1992, 30 000 in 1993 and 60 000 in 1994.

The management of each forest is based on the following principles:

- mapping, overall and detailed;
- inventory, marking of trees for harvesting and systematic thining (silvicultural treatment);
- creation of main and secondary roads;
- sale of standing timber on lots averaging 250 ha, at prices determined according to species.

The programme's success and its integration in the Guyanese timber industry will make it possible to preserve 5 to 6 million hectares of virgin forest from all human penetration. This is considered essential to safeguard the environment.

4. THE AMAZONIAN AND ANDEAN COUNTRIES

BRAZIL

The subject of forest management in Brazil has already been outlined in the previous chapters. Two different types of project are being conducted, one, in the Tapajos forest and the other in the Antimari forest.

. TAPAJOS: in 1978, the Brazilian Government and FAO initiated this wide-ranging project as a long-term pilot demonstration in the Tapajos National Forest, located in the Amazon Basin. The goal was to utilize the ecosystem for multiple purposes, including timber production, applying "natural" silvicultural treatments. The project was preceded by a series of inventories and silvicultural experiments conducted jointly by the Brazilian Government and FAO in the 1950s and '60s. The preliminary feasibility study, which included a sensitivity analysis, had shown that a high internal rate of return could be maintained even in the case of uncreasing operating costs and a sharp decline in wood prices.

A full management plan was developed, taking the recommendations of forestry experts into account. According to the 1978 inventory, the Tapajos forest had 54 m^3/ha of roundwood with diameter breast high over 45 cm, of which 36 m^3 belonging to 28 high-grade species. In 1979, experimental felling over 64 ha yielded 72 m^3/ha, of which 64 m^3 of commercial species. The gross volume of trees with diameters over 55 cm was 132 m^3/ha. The final project report (UNDP/FAO, 1983) presented the results of the full detailed study conducted by

15 international experts and 30 Brazilian researchers. The report indicated that it would be technically feasible and economically viable to create the permanent canopy in selected Amazonian areas comparable to the Tapajos National Forest. The studies provided important data on operations. According to one assessment, felling yielded 27 000 m^3 in 1980, 25 000 m^3 in 1981 and 17 000 m^3 in 1982.

The 1982 UNDP/FAO review mission noted the optimism and spirit of enterprise reigning among project personnel, but pointed out that actual forest management had not yet begun. It observed that to make sure the Tapajos timber would be processed, it would be essential to control factory inputs from external sources. In general, the region's factories already had a sufficient supply of logs, thanks to clearing operations subsidized by the Instituto Nacional de Colonizaçao e Reforma Agraria: felled logs were recovered from the roadside practically cost-free. The mission concluded that it would nonetheless be possible to manage Tapajos profitably, and that failure to commence commercial exploitation by mid-1983 would be cause for concern.

Since 1985, the project has been geared mainly towards the dry region of northeastern Brazil. The Government is pursing a study project at Tapajos, but management for sustained industrial production was at a standstill until 1989.

At that point, the project was revised in view of utilizing 1 000 hectares of virgin forest over a five-year period; the results to date are to be applied to establish sustained management over an area of 132 000 hectares.

ANTIMARI: this project is being developed in the Antimari National Forest, located in the State of ACRE. It was launched in 1989 by FUNTAC (Fundaçao de Tecnologia do Acre), a State organization that operates with the support of ITTO (International Tropical Timber Organization).

The project aims to work out a multiple-use model of forest development, taking into account the socio-economic context and environmental impact. Antimari is a production reserve in which the hydrological, botanical, edaphic, social and economic effects of development are monitored and controlled. Current operations include very large harvests of rubber, Brazil nuts and wood that employ local labour and involve considerable efforts by CNS (Conselho Nacional de Seringueiros).

Preliminary studies (still in course) envisage the harmonious development of these resources "for" and "by" the local people, by means of silvicultural and logging schemes that aim to establish sustained management of the whole ecosystem.

COLOMBIA

A management project was implemented from 1965 to 1970 on around a million hectares of low-altitude rainforest in the Serranía San Lucas, between the Río Magdalena and the Río Cauca.

The goal was to maintain and improve stand productivity by successive low-intensity fellings. Unfortunately, the site was abandoned in 1970 for security reasons (R. Schmidt, 1987).

By contrast, the forests of Guandal and Catival, whose silviculture is becoming better known, have no management plans despite their economic potential, their relatively large area and their structure, which would make management techniques easy to apply.

Lastly, SMURFIT CARTON DE COLOMBIA, a paper-manufacturing company with logging operations in the Pacific coast rainforests, has a 61 000 hectare concession at Bajo Calima, of which 60% are devoted to uses other than pulp, some areas being reserved for the local population and others "fully protected." The remaining 24 000 hectares are destined for pulp production (the company consumes 80 000 m^3 of wood per annum) on a thirty-year felling cycle. Logging operations are carried out via suspended cable to reduce their impact on the land. Unfortunately, the pressure of human population is such that rural people have already occupied some of the clear-felled areas (M. Kiernan *et al.*, 1991).

ECUADOR

After the opportunity to manage the Pacific forests was missed, and no management project similar to FAO's at ESMERALDAS was commenced, the Amazonian forests are now the only prospective object of management.

They cover an area of more than 10 million hectares, of which more than 3 million lie above 600 metres (premontane forests) and 7 million are rainforests. Two-thirds of the region is under concession to forest industries. The AIMA users association has established guidelines favourable to the notion of sustained management, but the situation is clearly compromised by pressure from farmers who take advantage of roads built by the oil companies. In 1989, deforestation was estimated to proceed at the rate of 75 000 hectares a year.

However, the following protected areas exist in the Cordillera:

- Parque Nacional Podocarpus
- Parque Nacional Sangay
- Reserva Ecológica Cayambe-Coca

and in Ecuador's Amazon area:

- Parque Nacional Yasuni
- Reserva de producción faunística Cuyabeno.

At present, Ecuador's Tropical Forestry Action Plan is attempting to improve the situation by encouraging rural community projects to protect the forests (primarily at the watershed level, in view of lengthening dam lifetimes).

BOLIVIA

There exists no forest management in the true sense of the term, though several operations have been attempted; for instance, the CDF conducted trials in the El Chore Forest Reserve, but they were avandoned due to pressure from settlers.

Most silvicultural activities concern pure wood plantations rather than forest enrichment strips.

Among the projects which support the lumber industry, we may mention:

- a project to get a better return from a 6 000 ha forest located in the Sacta valley; the forest is the property of Cochabamba's Universidad Mayor de San Simon and the project benefits from outside aid and support from the University's School of Forestry (Escuela Técnica Superior Forestal);

- community associations and cooperatives have been created at Zaporo (since 1982) and Lomerio (since 1984) for improved farming and forest management; 72 000 ha are involved at Zaporo and 72 000 at Lomerio;

- similar projects are being created with CDF support.

The most important project is the one being developed in the Los Chimanes area. It envisages a preliminary management plan covering more than 570 000 ha, ecological research at the BENI biological station, and an environmental education and training campaign.

More particularly, sustained use of wood resources is to commence in agreement with lumber concerns that have permits to operate in the region. A special silvicultural research programme will provide indispensable support for rebuilding the wood potential. The project is supervised by an interorganizational technical commission and receives substantial aid from the International Conservancy Foundation, the International Tropical Timber Organization, and other sources.

As in most countries of this region, the private sector does not see the advantage of medium-term investments in forest management, and is still less disposed to invest in long-term plans. Only tax incentives could modify this situation, but any new (beneficial) provision in this direction would be doomed to failure in the absence of a preliminary (and urgently needed) plan governing settlement and land use.

In addition, no forest policy can be applied and enforced without first assembling the necessary resources (especially well-trained and efficient personnel) and technical competence (at present the level of knowledge is poor, national inventories are inadequate

or non-existent, research is inadequate). Efforts to increase the extension of reserved forests and protect the national forest heritage will make no sense and have no real impact unless these obstacles are overcome.

PERU

Several large-scale forest development projects such as FAO's von Humboldt project and the Palcazu project (cf. the case studies below) are designed to establish forest management based initially on zoning and subsequently on the application of silvicultural techniques to achieve sustained forest production.

But in reality, these land management projects are unable to resist demographic pressure and uncontrolled clearance for farming. The future of forest management will depend in the first instance on whether Peru is able to formulate and enforce a clear and realistic agricultural development policy.

VENEZUELA

The establishment of Forest Management Plans is mandatory on both State-owned and privately owned forestlands. The only difference is in the type of contract involved; long-term contracts for managing State forests, job contracts for private owners.

Management plans must meet a "minimum standard" as regards projected felling rates and annual production estimates. As a rule, private and mixed enterprises retain forestry experts to develop their management plans. The plans must include preliminary estimates of the forest resource; describe the physical and ecological environment, including access roads and logging tracks; specify felling methods and schedules and illustrate not only the economic and industrial aspects, but also silvicultural treatments, forest research and monitoring programmes.

While the "minimum standard" is theoretically complete and detailed, in practice it is difficult for management plans to meet it. For one thing, resource estimation methodology is generally inadequate, due to the lack of maps and photo-interpretation, and to the difficulty of sample verification. The same can be said for the other items supposedly covered in management plans.

The defect of this arrangement is that logging contractors, backed by forestry experts, are actually left to their own devices.

In principle, managed forests are divided into annual coupe compartments, but compartmental production potential is never the same from year to year, or fails to match the established species and quality quotas, which may be met by logging in the adjacent compartments. What is more, the most accessible compartments are normally overtapped. Of course these effects are inevitable in any kind of planning, but they do go to show the administrative and impractical character of these plans, which the forest service tends to

rubber-stamp rather than verify. As to silvicultural treatments, in the absence of tested protocols the concessionnaire is not obliged to apply them, only to set up trials (during the first two years of the permit).

By way of example, in the 3.2 million hectare Imataca Forest Reserve, around 920 000 ha are presently under management plans and the same number will be brought under management in the future, attesting to a considerable organizational effort on the part of the forest administration. But in addition to the deforestation problem mentioned earlier, it is necessary to consider that these forest management plans can have no real impact (in terms of economic, social and ecological benefits) unless they are firmly grounded on integral and consolidated studies of the resource, of its effective mobilization, of the markets, of the local environment, and so forth; that is, on accurate analyses of the whole wood industry (Master Plan). Lastly, it must be remembered that if the concessionnaire has really envisaged a felling cycle of 20 or 30 years (or shorter), he would not use the excuse of inadequate knowledge and just set up a handful of silvicultural trials which would serve mainly as an alibi.

VIII. CASE STUDIES

1. CASE STUDY NO. 1: SURINAME - THE CELOS MANAGEMENT SYSTEM

Lack of success in converting forests into plantations led the Suriname Government, in collaboration with the Netherlands, to inquire into the possibility of developing a forest management system suited to the ecological conditions of the natural lowland ecosystem. As an overall design requisite, management goals and resources would have to be adapted to fit the ecological realities. The system is therefore based on two major elements - strict control of utilization (the Celos Harvesting System), and further silvicultural operations (the Celos Silvicultural System) - which, taken together, make up the Celos Management System.

1.1 The Celos Harvesting System (CHS)

The purpose of the Celos Harvesting System is to reduce the costs and damages of forest utilization. Damage to the soil and the remaining growing stock has been reduced by strict control of logging operations. Costs have decreased due to better planning of operations, with the timber companies assisted by silvicultural experts.

The CHS proceeds as follows:

- full inventory of exploitable trees;
- preparation of a compartment plan indicating the location of trees to be felled, future logging tracks and stockyards. The selection of trees for felling is made in collaboration with a silvicultural expert who generally limits the total volume to 20 or 30 m^3/ha;
- felling (aligned if possible) is organized so as to limit damage and facilitate haulage (logs should fall at an angle of 10 to 60° to the closest track);
- logs (less than 60 cm in diameter) are dragged out as far as possible, to limit the passage of heavy-duty equipment through the forest;
- the logs are then hauled to the stockyards on permanent tracks which are used for each successive silvicultural operation;
- the trees are numbered after felling so that the outflow from the forest can be controlled.

As regards soil damage, less than 15% of the surface area is affected, compared to 25% in conventional logging operations.

1.2 The Celos Silvicultural System (CSS)

The system was designed pursuant to a series of experiments and measurements. The following section outlines the history of this research and describes the system finally adopted.

1.2.1 History of research leading to the CSS

The experimental site is located at Mapane and Kabo, 100 km from Paramaribo. The region is characterized by annual rainfall of 2 000 to 2 500 mm and very poor soils (high

aluminium content, low phosphorus and potassium). The forest has a wealth of species (at Kabo, 108 species were counted on one hectare), and the living phytomass amounts to 480 t/ha. The living phytomass represents from 70 to 90% of the ecosystem's total phytomass (with the notable exception of nitrogen).

Four successive experiments were conducted in this ecosystem:

. The first, which began in 1965, was designed to study the feasibility of a mono-cyclic system. Operations consisted of culling secondary species that limited sapling regeneration and growth. The two post-logging operations were cutting creepers and thinning. After 14 years of measurements, the system showed its potential for encouraging the regeneration of high grade species. However, the structure of the resulting stand was much altered, and silvicultural costs were prohibitive.

. The second approach consisted of monitoring a lightly-logged forest to which no further silviculture was applied. Nine years of measurement sufficed to show that high-value species were growing relatively slowly. The growth rate compared to mortality was judged too slow to serve as a basis for sustainable management.

. In the third experiment, several different silvicultural treatments were tested on lightly logged 0.64 ha plots. Two types of thinning (20 - 40) were combined with 3 types of clearing (A D S):

Type 20 thinning:	performed in year 0 on trees with diameters of 20 cm and more
Type 40 thinning:	performed in year 0 on trees with diameters of 40 cm and more
Type A clearing:	clearing of 25 m^2 plots around the most promising trees
Type D clearing:	systematic clearing of saplings with diameters of over 2 or 5 cm (D2 or D5)
Type S clearing:	clearing of east-west strips

Tree growth and ecological and economic parameters were measured annually over a period of 12 years. The "20 + D5" treatment was judged best.

. In the fourth experiment, the "20 + D5" treatments was tried out on a "life-size" 16 ha plot. The results are too recent for a definitive assessment, but it is possible to estimate the gains as compared to the control plot.

	Control	20 + D5 treatment
Increased volume of commercial species (m^3/ha/yr)	0.2 m^3	2.0 m^3
Mortality rate (% of incidence)	2.0%	1.4 to 2.6%

Hence the "ideal" treatment is as follows (see figure):

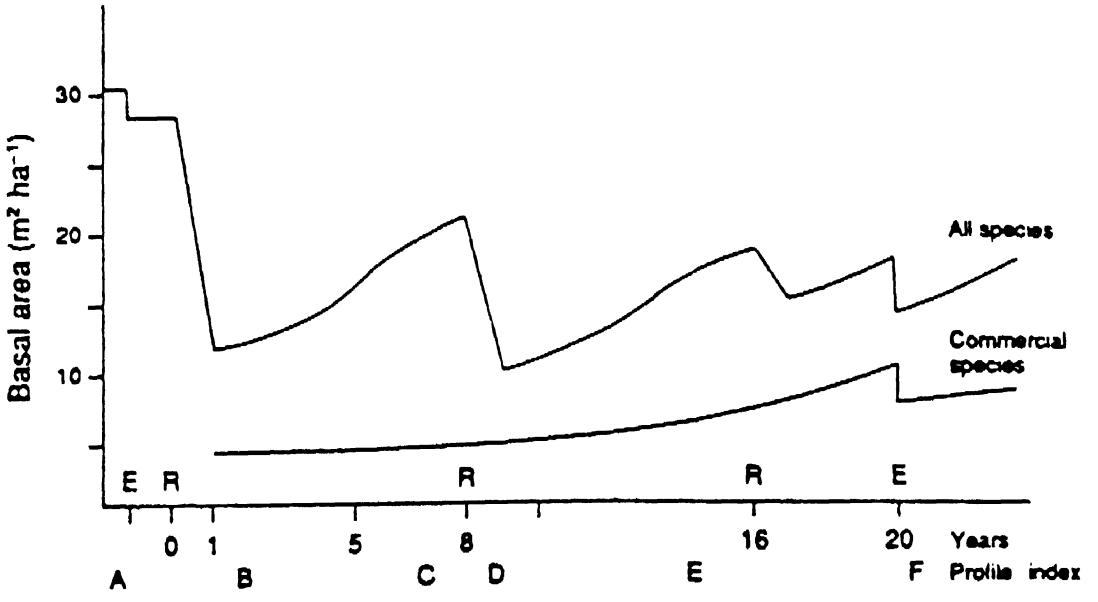
1st thinning 1 year after logging (t_{0+1}): secondary trees over 30 cm in diameter are eliminated by devitalization (poisoning).

2nd thinning at t_{0+8}: secondary trees over 10 cm in diameter are devitalized.

3rd thinning at t_{0+17}: clearance of some undesirable trees and creepers.

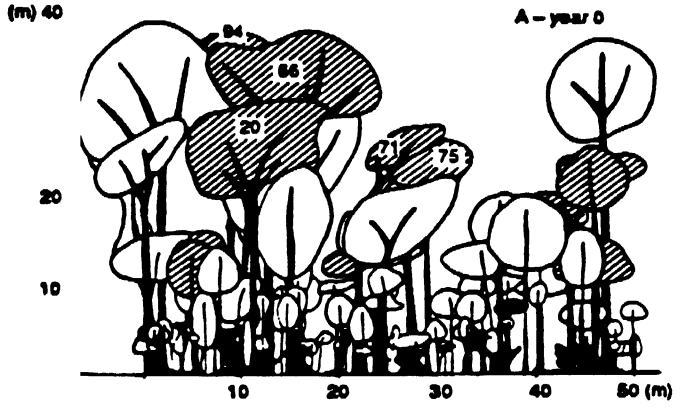
t_{0+20}: second logging.

The projected development of the total basal area is shown in the following figure.

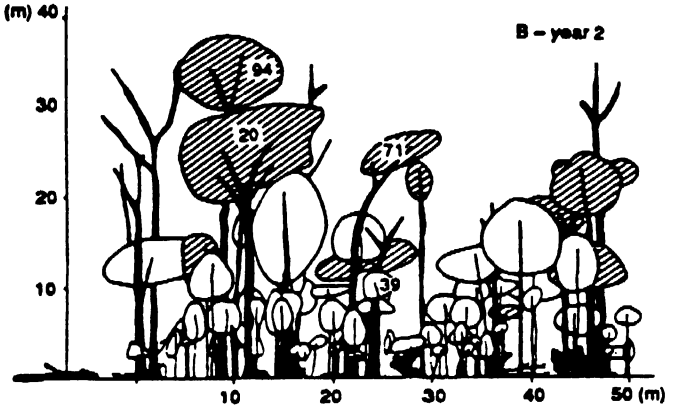


Projected development of basal area of all species and of basal area of commercial species, under the Celos Silvicultural System proposed for the Mapane region. Time of: exploitation = E; refinement = R; forest profile diagrams in Figure 27.1 = A – F

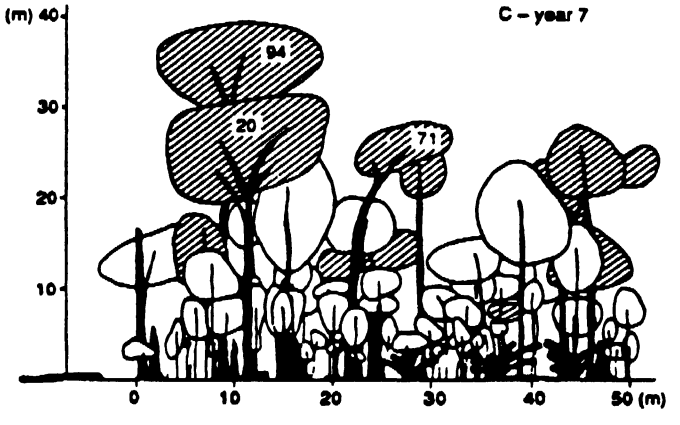
SUCCESSION OF TREATMENTS



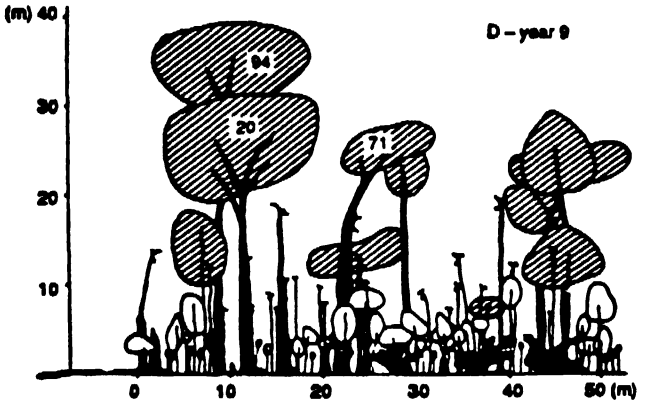
Year 0: Before treatment (commercial species shown with shaded crowns)



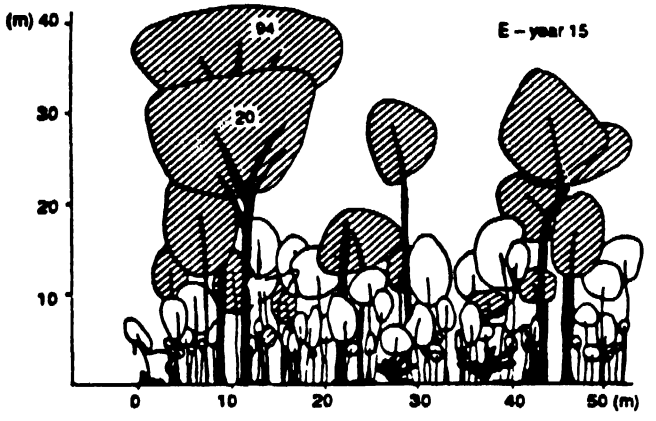
Year 2: After felling (trees nos 66 and 75) and thinning of "non-commercial" trees with diameters of over 30 cm



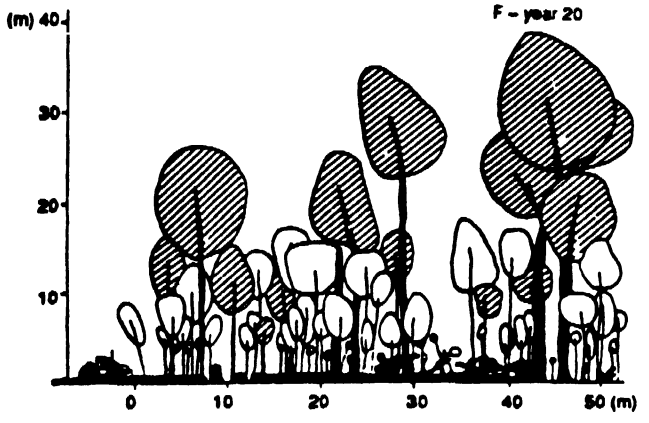
Year 7: Just before second thinning (growth of commercial species)



Year 9: After second thinning (culling "non-commercial" trees with diameters of over 10 cm)



Year 15: After a third light thinning (tree no. 71 fell= natural mortality)



Year 20: After creeper removal in the 17th year and felling of two other high-grade trees (nos. 20 and 94). The remaining stand has a large number of future trees, with a good representation of so-called secondary species.

1.3 Mono- or poly-cycle system?

The mono-cyclic system is particularly intensive. The basal area is reduced from 28-30 to 3.5 m^2/ha! In these conditions, a stock of seeds and seedlings of merchantable species is vital for the future (the next coupe is 60 or 80 years ahead).

Two main factors explain the rejection of this method:

- very high costs of the cleaning and creeper-cutting needed for seedling survival;
- generally slow stand growth.

In addition, the damage that the second logging will probably produce seems too great. Lastly, this long-term operation cannot rest on reliable projections about the stability of wood prices.

Preference was therefore given to the poly-cyclic system defined after research. Under this system, most of the stand consists of trees of commercial species with diameters between 20 and 30 cm. These represent the future stand and after 20 years should attain a diameter of 45 cm (exploitable diameter). If ten trees are felled per hectare in the first coupe, fifteen to twenty future trees must remain in the stand. This system appears to be low-cost and easier to implement.

As to the ecological aspect, the still-unpublished findings of recent studies seem to indicate that the system does not greatly affect the relevant parameters. There is little nutrient loss, changes in bird populations occur but without apparent consequences, specific diversty is slightly reduced but still high, and the application of very small quantities of chemicals (2 l/ha) does not damage the ecosystem. In short, the negative ecological effects of this silvicultural system are very slight, and it protects the forest better while sharply increasing its economic value.

1.4 Conclusions

The Celos Management System (CHS + CSS) seems economically and ecologically appropriate for the management of permanent forests under acceptable market conditions. At present, however, a system of this kind cannot be envisaged in countries where wood harvested during clearance for farming is dumped on the market at cut-rate prices.

The system also offers a significant advantage to logging contractors: production per hectare is higher and more regular. In addition, permanent tracks can be opened, and transport costs do not increase as felling sites are shifted further into the forest.

By way of example, a permanent forest of 50 000 ha managed under the CMS can sustain a mid-sized timber industry: 150 people can thus be employed in silviculture. This kind of forest thus has a place of its own in the management of land lying between protected areas and production areas.

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2. CASE STUDY NO. 2: RESEARCH ON CLOSED FOREST MANAGEMENT IN THE BRAZILIAN AMAZON

Brazil has long experience in managing closed forests. This research commenced in 1958 at the CURUA-UNA station with technical assistance from FAO. Silvicultural studies on closed forests conducted by two other research organizations, EMBRAPA (EMPRESE BRASILEIRA DE PESQUISAS AGROPECUARIAS) and INPA (INSTITUTO NACIONAL DE PESQUISAS DA AMAZONIA) also give a better understanding of the possibilities of sustained management of the natural forest. The major contributions to date are as follows:

2.1 CURUA-UNA

The CURUA-UNA forest research station is located near SANTAREM in the State of PARA (2°23' S, 54°24' W). At present it is being run by SUDAM (Superintendencia de Desenvolvimiento da Amazonia) with technical assistance from the forestry department of FCAP (Faculdade de ciencias Agrarias do Para). From 1958 to 1967, research at Curua-Una was conducted by FAO.

Several trials have been conducted:

a. TSS (Tropical Shelterwood System)

This silvicultural technique was established in 1961 on an area of 6.25 hectares (250 x 250 m). The steps were as follows:

* two to four years before logging, the canopy was opened by poisoning 25 large trees and 40 to 42 smaller trees of non-commercial species.

* Logging.

* A few years later and until 1967, silvicultural treatments were applied in the upper storey.

* At present, the stand is dominated mainly by Quaruba verdadeira (*Vochysia maxima*), as well as Marupa (*Simaruba amara*), Morototo (*Didymopanax morototoni*) and Cupiuba (*Goupia glabra*), with trees up to 55 cm in diameter.

Attempts at enrichment with Anderson type plots have not produced satisfactory results except with Andiroba (Carapa guianensis), though here there have been problems of bifurcation at 10 m due to borers.

b. Natural regeneration in strips (after commercial exploitation and felling flush to the ground in 1959 on a 4 ha area)

This was an attempt to reclaim the second-growth forest with light-demanding pioneer and non-pioneer commercial species. The species which are most abundant and grow fastest to a diameter of 60 cm are Morototo, Quaruba and Cupiuba. Bifurcation of some Cupiuba reduces their commercial value. This treatment was costlier than expected because of felling and hauling expenses.

c. Selective felling management systems

From 1970 to 1981, logging operations were conducted on two 100-hectare plots. A FCAP team is now monitoring the adult stand and natural regeneration. According to a preliminary analysis, only 10% of the biomass felled during the operations was sold. During the felling and hauling of eight or nine trees/hectare, a total of 3 700 m^2/ha were cleared.

Ten years after logging, the naturally regenerated stock of commercial species has grown by 59%.

Average girth growth is 0.42 cm/year; starting in the fourth year, these values begin to diminish.

Studies have been conducted on interspecies interactions. Seven distinct forest associations were identified on seven sites over an area of 100 ha. At present, a large-scale pilot management project is being set up at Curua-Una. In 1987, 1 000 ha were inventoried; the logging will be done by a private contractor.

2.2 Tapajos National Forest

EMBRAPA-BELEM's Forestry Department has conducted research on natural forest management in Tapajos National Forest (2°45' S, 55°00' W, at Km 67), which occupies 600 000 ha in the state of Para, 65 km south of Santarem between the Cuaba-Santarem highway and the Tapajos River. A number of experimental compartments were set up:

a. Km. 67 - In a 64-hectare compartment, creepers were cut and undesirable dominant trees girdled (76% effectiveness after 3 years); dual-intensity commercial logging (exploitable diameters of 45 and 55 cm) was conducted in 1979. Logged volume was 75 m^3/ha (of which 64 m^3 commercial species), or 16 trees/ha, belonging to 63 species.

Monitoring over a period of eight years after logging showed that average girth growth in the 297 species present in the compartment was 0.5 cm/year.

Growth of the same order was found for the group of 29 commercial species considered. At the species level, growth varies greatly. Pioneer species grow fastest, generally more than 1 cm/year. By contrast, the growth of climax species is in the order of 0.1 cm/year.

During the period from 1981 to 1983, average annual growth in basal area for 45 and 55 cm treatments was 0.26 m^2/ha/yr and 0.13 m^2/ha/yr respectively for commercial species, 1.46 m^2/ha/yr and m^2/ha/yr for all species.

Light strongly influences growth. Trees grow up to 200 times faster in full sunlight than in diffused or lateral light. The beneficial effect of opening the canopy ends three or four years after logging, although certain species continue to grow rapidly even eight years thereafter.

The logging was considered too intensive for sustained poly-cycle management.

A 30-year projection (to 33 years after logging) showed that as things stand, no further logging will be possible at the end of the cycle. However, it would be possible if silvicultural treatment were applied, and provided other commercial species appear on the market.

b. Km. 114 - Experimental compartment of 144 hectares logged in 1982 with four treatments:

   . T1 - logging of commercial species with diameters exceeding 45 cm.

   . T2 - logging of species with diameters exceeding 55 cm, plus 30% reduction of the basal area;

   . T3 - logging of species with diameters exceeding 55 cm, plus 50% reduction of the basal area;

   . T4 - logging of species with diameters exceeding 55 cm, plus 70% reduction of the basal area.

   Several different research projects are under way:

   - Study of the impact of logging on the stand

   - Study of phytosociological and ecological parameters

   - Regular inventories.

c. Km. 83 - 1 000 hectare comportment to study the technical and economic feasibility of a poly-cyclic mangement system. Exploitation commenced in 1987 with low-intensity felling of 35 to 40 m^3/ha, or six trees/ha.

Devitalization (by cutting notches and spraying arboricide into them) will reduce the basal area to a third of its present size, and will be followed at intervals of eight to ten years by other silvicultural treatments in a 20 to 25 year cycle.

2.3 ZF2

This rainforest management project is being conducted by the INPA Forestry Department on a 21 000 ha concession which the Institute acquired in 1970. The site is located about 90 km north of Manaus in the State of Amazonas (2°37' S, 60°'09' W).

The project involves an area of 72 ha situated around the INPA camp on Track ZF2. It includes three 24-hectare blocks, isolated from each other. Each block is made of six contiguous 4-hectare compartments. Fifty-meter-wide buffer strips around the compartments eliminate border effects. Measurements are made on 15 one-hectare plots, since the three outer plots are not considered.

All trees with diameters of 10 cm or more have been inventoried, identified, numbered and mapped. Measurement heights are painted on the trees.

Merchantable species represent a third of the inventoried population, which totals 324 species excluding palms and creepers.

The inventory of natural regeneration showed that there is an inadequate stock of saplings in the first juvenile phase (diameter less than 5 cm, height 30 cm or more), but the stock of saplings in the second juvenile phase (diameter over 4 cm) is satisfactory.

Girdling trials on 29 species produced a mortality rate of 68.5% at the end of two years.

In 1987 and 1988, logging operations were carried out with three different intensities, namely on exploitable diameters of 55, 50 and 40 cm; 24 m^3, 30 m^3 and 44 m^3 were felled per hectare repectively, or 5, 8 and 16 trees per hectare.

Logging and hualing had a considerable impact on the stand (from 7 to 17 trees with diameters of 10 cm or more died for each tree felled). 27% of the trees felled were mainly calibrated on Angelim pedra (*Dinizia excelsa*) and Tanimbuca (*Buchenavia parvifolia*).

Logging created gaps ranging from 36 m^2, to 2 500 m^2, 80% of which are less than 600 m^2.

According to the most recent inventory (1991), the stand reacted strongly to exploitation.

The growth rate rose, mainly to the benefit of small- and medium-sized trees (10 to 40 cm). As regards the merchantable species, diameter growth increased from 0.2 cm/yr before logging to 0.4 cm/yr after.

Recruitment was greatly stimulated; not only have many pioneer species appeared, but also merchantable species (1 stem/yr on the control plot, 4 stems/yr on the exploited plots.

Mortality due to the long-term effects of logging was still quite high in 1990, but the 1991 inventory shows it has since fallen off sharply.

In the 10 to 40 cm diameter class, the balance of merchantable trees varies from 1.20 to 1.80 m^3/ha after treatments, which are still undifferentiated. In the control plot, the balance is 0.60 m^3/ha.

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3. CASE STUDY NO. 3: REPUBLIC OF GUYANA - THE PARACOU PROJECT

The project titled "SILVICULTURAL RESEARCH ON CLOSED FOREST STANDS" commenced in 1983 with the aim of answering two questions posed by forest managers:

"What are the possibilities for rebuilding stand potential after initial logging? What simple and low-cost steps can be taken to encourage the growth of merchantable species and thereby ensure sustained timber production?"

The project was set up by CTFT (Centre Technique Forestier Tropical), a department of CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement), in collaboration with INRA (Institut National de la Recherche Agronomique), which is charged with studying understorey regeneration (tress with diameters of less than 10 cm).

The main purposes of the study are:

- to develop and test simple silvicultural techniques: thinning and logging;
- to study the effect of these treatments on the behaviour and growth of various species;
- to study the evolution of stands as a whole (mortality, natural regrowth of saplings, effect on creepers and regrowth, and so forth), again in relation to the silvicultural treatments;
- to verify the favourable or unfavourable growth of seedlings and saplings (regeneration);
- to quantify the effect of the various treatments on production, define the treatment best suited to the physical and yield constraints, and determine the gains that can be achieved thereby.

3.1 Project description

The project is located inside CIRAD's Paracou-Sinnamary concession, around forty kilometres from the city of Kourou.

At the outset, the site comprised 108 ha of primary evergreen forest divided into 12 square compartments of 9 ha each, plotted out after a detailed survey of an area of over 450 ha, including a soil survey by ORSTOM (French Institute of Scientific Research for Cooperative Development) and a count of all trees of merchantable species.

Sitting priorities were as follows:

- Possibility of measurement and exploitation: adequate presence of all sizes of high-value species;

- Representativity of the soil: mainly shallow drainage basement, as this is the type of cover on almost 80% of the nation's land.

To date 62 tree species have been botanically identified (there are probably around 300 within the project area), but more exhaustive identification is in course.

Fifty-eight of the identification species have been labelled "PRINCIPAL", and form a group that includes both currrently marketed timber species and other technologically valuable species for which demand is still low. At present only 20 or so species are marketed. Generally speaking, the angelica tree (*Dycorinia guianensis)* accounts for a third of total production volume; *Qualea rosea* and *Ocotea rubra*, taken together, account for another third. In other words, only three species make up two-thirds of total log production.

Species found frequently in Paracou:

		% of basal area
Licania spp. and *Parinari* spp.	Chrysobalanaceae	12%
Eschweilera spp.	Lecytidaceae	11%
Eperua spp.	Caesalpiniaceae	9%
Qualea rosea and *Ruizteriana albiflora*	Vochysiasceae	5%
Vouacapoua americana	Caesalpiniaceae	3%
Dicorynia guianensis	Caesalpiniaceae	1%

Number of trees with diameters of over 10 cm:	83/ha (principal species) 608/ha (all species)
Corresponding basal area:	14 m^2/ha (principal species) 31 m^2/ha (all species)
Corresponding volume:	173 m^3/ha (principal species) 360 m^3/ha (all species)

Initial measurements and tree localization were completed in 1984, after the nine compartments had been marked off. All trees with diameters of 10 cm or more were fully identified in the central 6.25 ha (250 x 250 m) plots in each compartment; that is, over a total of 75 hectares.

All of the approximately 46 000 trees, whether belonging to principal species or not, were numbered, identified (if belonging to principal species) and localized according to the conventional system of perpendicular coordinates.

Girth measurements have been made annually since 1984 at the height of 1.30 m.

3.2 Silvicultural treatments and their impact

An initial measurement campaign was carried out in the virgin forest over a period of two years, up to the third inventory and the demarcation of test plots.

A series of four treatments (applied over the whole of the 9-hectare plot) began in 1986 and were repeated three times:

First treatment: Conventional logging, extended to several species of tested technological value for which demand is still low (minimum exploitable diameter varied between 40 and 60 cm, depending on the species). The felling rate averaged 10 trees per hectare, yielding 50 m^3/ha of timber.

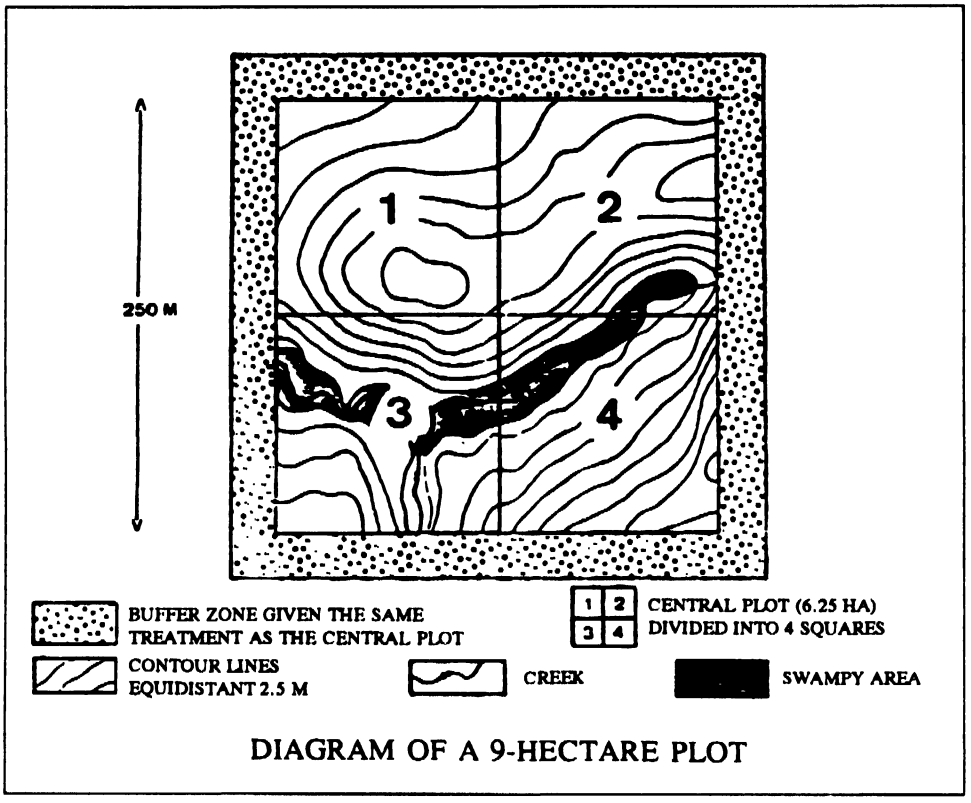


DIAGRAM OF A 9-HECTARE PLOT

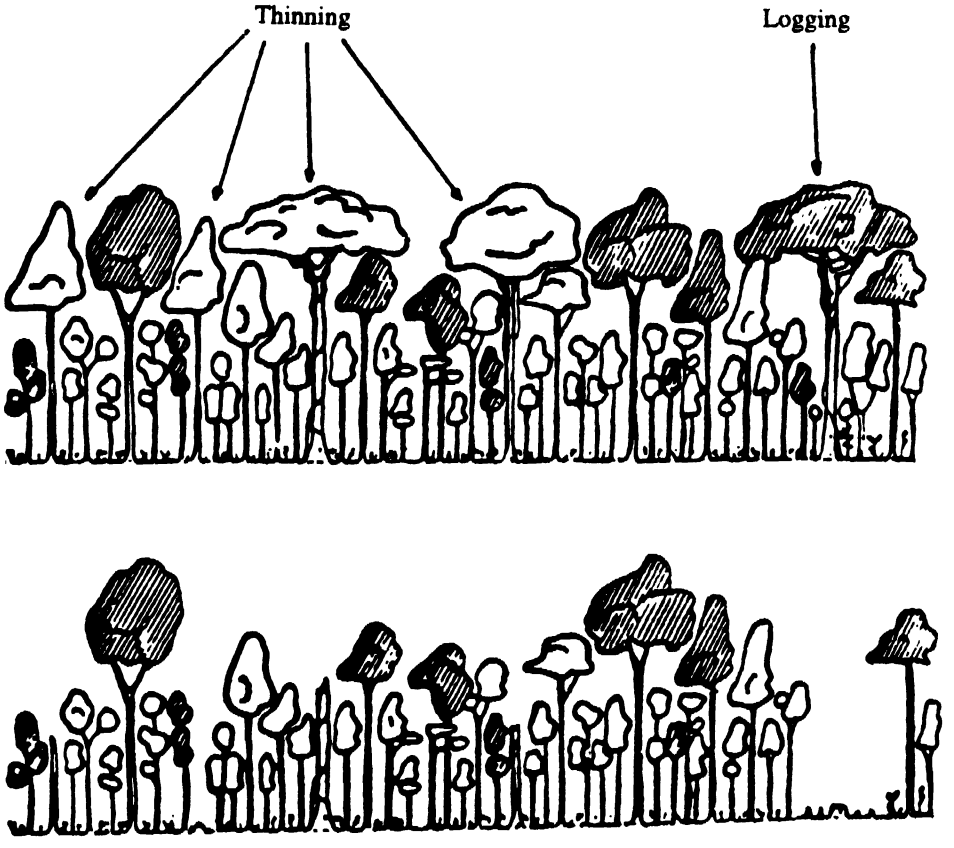
Second treatment: Logging operation identical to the preceding one, but with complementary thinning, effected by devitalizing secondary species without technological value, as well as some malformed trees of the principal species, with diameters over 40 cm (devitalization accomplished by notching the trees and applying arboricides). Thinning eliminated around 30 trees/ha, or 80 m^3/ha.

Third treatment: Logging of the same kinds of timber as before, but also of secondary species with diameters of 40 to 50 cm for use as fuelwood, plus thinning of trees belonging to secondary species with diameters of over 50 cm. This operation produced nearly 30 m^3/ha fuelwood (20 trees/ha) and devitalized 14 trees, or 50 m^3, per hectare.

Fourth treatment: The forest is left untouched and serves as a permanent control for quantifying the effects of the three previous treatments.

The following drawing depicts the second treatment:

TREATMENT COMBINING LOGGING AND THINNING
(Crowns of valuable species are shaded)



Stand status before and after treatment:

Following are the approximate percentages of basal area reductions by logging, thinning and incidental damage:

1st treatment: 17% of the basal area
2nd treatment: 42% of the basal area
3rd treatment: 47% of the basal area

		1st treatment		2nd treatment		3rd treatment	
		Principal	All	Principal	All	Principal	All
Stand before treatment	N/ha	172.1	595.1	172.9	612.7	164.6	613.3
	BA/ha	13.46	30.46	13.63	31.72	13.64	31.80
Felled trees	N/ha	10.1	10.1	10.9	10.9	14.7	28.9
	BA/ha	3.25	3.25	3.81	3.81	4.13	6.30
Broken trees	N/ha	17.1	69.4	17.5	74.5	28.9	133.5
	BA/ha	0.64	1.94	0.75	2.19	1.05	3.62
Devitalized trees	N/ha	0.0	0.0	4.4	28.8	5.1	15.0
	BA/ha	0.00	0.00	1.40	7.41	1.84	5.03
Total "eliminated"	N/ha	27.2	79.5	32.8	114.2	48.7	177.4
	BA/ha	3.89	5.19	5.96	13.41	7.02	14.95
Stand after treatment	N/ha	144.9	515.5	140.1	498.5	115.9	435.9
	BA/ha	9.57	25.27	7.67	18.31	6.62	16.85
Intact trees	N/ha	128.7	454.0	122.5	439.5	93.6	343.7
	BA/ha	8.53	22.52	6.69	16.08	5.44	13.26
Damaged trees	N/ha	16.2	61.5	17.6	59.0	22.3	92.2
	BA/ha	1.04	2.75	0.98	2.23	1.18	3.59

N/ha = number per hectare; BA/ha = basal area per hectare

Felling and hauling damaged the stands (trees uprooted or broken, damaged crowns and boles) and disrupted the soil (compacting, ruts, and so forth). Mortality due to logging operations is proportional to their intensity, which entails the destruction of 6 to 12% of the basal area, or the death of 6 or 7 trees with diameters over 10 cm for each tree logged.

Logging-related mortality may continue for some years, as trees that have been wounded or canted or otherwise weakened slowly die off.

By contrast, devitalization causes little damage to neighbouring trees (less than one tree with diameter over 10 cm for each devitalized tree). Three years after this treatment, 90% of the devitalized trees are dead (the sapotaceae are the most resistant). The elimination of large trees by devitalization causes minimum damage while achieving the purpose of opening the canopy.

As to the timber yield, only 30 m^3/ha were transported to the sawmill, as against the inventoried potential of nearly 75 m^3/ha.

Trees were declassified throughout the logging operation: 25 m^3 remained standing, and of the 50 m^3 felled, 20 m^3 were abandoned during the operation (due to cracks, rotted hearts, breakage, hauling losses, wastage, and so forth), despite the care taken in the framework of a research project. Certain species such as *Eperua* spp. are characterized by a very low marketability factor.

3.3 Principal results

The most recent data were generated by the 1990 measurement campaign (four years after logging and three after thinning). Although these early results are only provisional, they are already highly promising.

In the control plot, the balance, in terms of basal area and volume, turned positive for the first time since 1987, due to a significant decrease of natural mortality linked to the fluctuations of a balanced stand.

Regarding the first treatment (exploitation, timber), the number of saplings with a diameter of 10 cm or more (regrowth) was twice as great as in control plots. The overall growth trend was of the same order, increasing (for the principal species) from 0.51 m^3/ha between 1988 and 1989 to 0.91 m^3/ha between 1989 and 1990.

As to the other two treatments, the balance is still clearly positive because the effect of devitalization on mortality is still operating despite the sharp increase in regrowth and individual tree growth (these stands are still stabilizing).

A comparision of average individual increments in the principal species shows that the trees react favourably to harvesting and even more when logging is combined with thinning. In 1990, the increment (compared to the control) was nearly 60% in harvested stands and 100% in those which had also been thinned.

Stand opening by harvesting and especially by thinning leads to a very favourable reaction in the great majority of species, especially as regards the smaller- and medium-sized trees. By contrast, the treatments have practically no effect on the dominant trees, which are subject to little competition from the surrounding stand.

Of course the trees do not all react to the treatment immediately, or in the same way. Reactions are affected by many different factors (genetic, pedological, and so forth).

Even under what appear to be identical conditions (type of silviculture, species, size), the rate of diameter growth will vary from tree to tree. On untreated plots, while most individuals of the same species and size grow at the same rate, some will grow much faster. Harvesting and thinning increases the ratio of fast-growing to slow-growing individuals. The same holds for regrowth: more stems attain a 10-cm diameter after these treatments.

Natural mortality, the original mechanism of forest self-regeneration (by windthrowing), is a very important phenomenon but unfortunately one which is difficult to quantify.

It has not been possible to establish any connectiion between the natural mortality rate and the intensity of stand opening: trees of all sizes die on both treated and untouched plots. Unlike diameter growth and regrowth, natural mortality is a discontinuous event-related phenomenon that can be evaluated only over very long periods of observation, just as in climatology.

The effort needed to reach a better understanding of windthrowing and die-back is all the more necessary in light of the fact that production losses due to mortality can be quite large, and may significantly reduce or even cancel out the exploitable potential.

These findings, which are similar to those from the CELOS project in Suriname and the INPA project at Manaus in Brazil, have made it possible to take steps towards sustained management of the forest ecosystem based on technical results that have been increasingly confirmed in the framework of Guyanese forest management (illustrated earlier).

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4. CASE STUDY NO. 4: PERU

THE ALEXANDER VON HUMBOLDT NATIONAL FOREST MANAGEMENT PLAN

4.1 Overview

In 1971 the Peruvian Government requested UNDP financing for a demonstration forest-management project in the Alexander von Humboldt National Forest in the Amazonian

basin plain. The long-term goals of this project, which was conducted from 1974 to 1978 (under the aegis of FAO), were:

- to increase sustained yields from the national forests via demostrations of management, improvement, protection and logging techniques;
- to maximize social and economic benefits via the development of an organized wood industry.

The project's short-term goals were:

- to determine whether it would be technically and economically possible to create a complex of wood-based industries;
- to study the regeneration of marketable species;
- to draw up a management plan for the von Humboldt National Forest;
- to conduct feasibility studies;
- to train personnel at all staff levels.

4.2 Brief description

The decision to create this forest in the Loreto and Huanuco districts of the Selva del Perú region into a natural forest was taken in June 1965. In 1974, its area was fixed at 652 000 hectares, of which 610 000 were considered available for management: 57 000 ha of protection forest and 553 000 ha allocated for logging, plantations and agro-foresty.

Von Humboldt is a (very) moist closed forest, with rainfall varying between 3 200 and 5 500 mm/year. Around twenty species belonging to the Bombacaceae, Moraceae, Sapotaceae, Lauraceae, Caesalpiniaceae and Lecythidaceae families account for 50% of the tree population.

There had been little traditional logging of high-grade species, due to the difficulty of extracting the products (to Pucallpa). The species in point were:

- Caoba — *Swietenia macrophylla*
- Cedar — *Cedrela odorata*
- Ishpingo — *Amburana cearensis*
- Tornillo — *Cedrelinga catenaeformis*

4.3 Project development

DGFF (Dirección General Forestal y Fauna) marked out a 200-hectare pilot demonstration area where various nurseries, camps and trials were established in 1974.

A series of inventories was made in 1971 according to different criteria (starting from diameters of 30 cm). The exploratory work showed that out of 300 species counted, 8 alone represented 42% of the total tree population, averaging 21 per hectare.

Moreover, sawnwood volume was concentrated in around twenty species averaging 21.7 m^3/ha; the most frequent were:

- *Eschweileira* spp.	(Machimango)	4.2 m^3/ha
- *Chorisia* spp.	(Lupuna)	2.3 m^3/ha
- *Pterocarpus* spp.	(Palisangre)	2.6 m^3/ha
- *Copaifera* spp.	(Copaiba)	3.5 m^3/ha
- *Hura crepitans*	(Catahua)	0.8 m^3/ha
- *Brosimum* spp.	(Chimicua and Panguana)	2.2 m^3/ha

During the project DGFF and FAO inventoried a 2% sample of four 50 000-hectare blocks (pre-defined by the 1971 survey) which presumably had the best development potential.

Comment: 25% sample was also inventoried within the 200-hectare pilot area, and two specific regeneration surveys were made of three size classes (0 to 3 m height, 3 m height up to 14 cm diameter, 15 to 39 cm diameter).

All these inventories showed that the forest's botanical composition was highly heterogenous, but commercial volumes were very homogenous. Twenty-one species accounted for three quarters of the commercial volume, and regenerated trees of 15 species represented 85 percent of the number of stems. Commercial volume increased from 15 to 30 m^3/ha over the period of the project because 20 new species were added to the list of high grade species. Economic analysis indicated that an investment of 26 million US dollars would be needed to complete the project; the internal rate of return was estimated at 12 to 17 percent, and cash flow was always positive.

The management plan allocated different zones to agrosilviculture, plantations, the natural production forest and the protection forest. From the silvicultural standpoint, management of the production forest was based on a 60-year rotation and a 30-year rotation felling cycle.

4.4 The management plan

A considerable research effort, with all kinds of trials, was undertaken to verify the recommendations dictated by the management plan. As regards the study of stand dynamics in particular, a group of 75 permanent plots were available but unfortunately were neither monitored nor protected (they were largely destroyed by farming).

The Management Plan proper was designed in great detail (J.L. Masson *et al*, 1979); the major components were:

- Application period: five years (with review every five years)

- Goals:

. protection for sustained timber production
. permanent supply to industry

. expansion of timber markets
. reforestation in degraded areas
. establishment of a complementary research programme
. creating a large number of jobs for the neighbouring workforce.

- Land allocation to four uses, with identification and demarcation of:

. production forest areas
. protection forest areas
. unusable areas (occupied by five "native" communities or farming)

- Major techniques:

. A 60-year rotation (with an interim coupe after 30 years) was established in relation to the 10 000 m^3 explotaible yearly in blocks of 6 700 hectares (average extraction: 15 m^3/ha).
. Definition of reforestation, strip enrichment and agroforestry techniques.
. Survey and listing of commercial species, and definition of the relevant extraction and processing methods.

- Procedures:

. Calculation of production potential: counts, maps, estimates of productivity.
. Road network: density calculation, definition of new main and secondary roads, etc.
. Logging: establishment of blocks, allocations, contracts and supervision.
. Cost calculation, personnel management, etc.

4.5 Outcome of the project

Although the Management Plan was well designed and the economic indicators were favourable, there was a lack of dynamism when it came to actually implementing it, and the actions were not carried out as planned.

For one thing, peasants occupied many exploited areas, including research plots, for shifting cultivation.

One of the main technical benefits was that the DGFF shouldered a large part of everything involved in the various experiments and trials: demonstration inventories, production of forest silviculture, road-opening, bridge-building, and so forth.

When the project ended in 1979, post-plantation operations and most of the research and development programmes were halted. But in 1981 another project supported by Japanese aid (AICA) took over the von Humboldt experimental station.

The new project includes plantation and enrichment trials, nurseries, road maintenance/improvement, and reactivation of the surviving FAO/DGFF research plots. Around a thousand hectares have been planted or enriched since 1982 (with some success).

Unfortunately, the post harvest recommendations contained in the Management Plan have not been followed at the country level. Although annual-coupe blocks or compartments have been established on the basic of a 40-year cycle, DGFF is unable to control concessionnaires logging operations.

In conclusion, it would seem that the project's failure was not due to technical factors. It was due mainly to the lack of determination and/or financial resources; in short, to its failure to receive sufficient priority at the national level.

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5. CASE STUDY NO. 5: PERU

THE PALCAZU VALLEY PROJECT

5.1 Overview

The PICHIS-PALCAZU project was conducted in the framework of a global integrated rural development programme; until 1988 it received financial support from USAID and technical support from TSC (Tropical Science Centre of Costa Rica).

Commencing in 1989, the project was run with the country's own resources for development of the Palcazu valley, which covers an area of approximately 295 000 hectares.

The forestry component was given the task of implementing sustained management of wood resources through the system of opening strips fully exploited by clear-felling (Fajas de aprovechamiento a tala rasa).

Work commenced in 1983 with a preparatory and training programme, and in 1985 the first two strips were clear-felled on an experimental basis, in order to study stand regeneration and reformation.

Other works were undertaken in parallel: inventories, road-opening, construction of a timber processing and utilization unit.

This series of actions was implemented through the creation of an initial forestry cooperative (Cooperativa Forestal Yanesha) whose members belong to the five communities directly involved in the overall project. Several other organizations, for instance the Fundación Peruana para la Conservación de la Naturaleza, gradually added their contributions, which became vital after USAID funding was withdrawn in light of the site's insecurity.

5.2 Principles

The project was designed to achieve sustainable rural development based on forest tracts felled and developed by rural communities.

The proposed techniques are based on the clear-felling of strips 20 to 50 metres wide; the cooperatives are to fell one adjacent (but not contiguous) strip each year.

In theory, the cooperatives should be able to sell the whole biomass for sawnwood, construction wood (fencing, poles, etc.), fuelwood or charcoal. It is also expected that regrowth of the secondary forest will preserve the biological diversity and environmental role of the climax forest. Lastly, a new harvest is envisaged at the end of 30 years, after thinnings for stand improvement.

5.3 Methodology

The methodology was developed in Costa Rica on the basis of studies conducted in secondary forests reformed after clearfelling (and abandonment).

The strips are 20 to 50 metres wide; their length depends on local topography and product removal logistics. The first two strips felled measured 20 x 70 and 50 x 100 metres.

After felling, the logs were dragged out by ox teams; the largest logs were sawn lengthwise to facilitate this operation. Roundwood was positioned at the side of the track and trucked to the processing unit. Construction wood was chemically treated; other wood was processed for charcoal. A Boucherie type wood-impregnation unit was installed at Shirimangazu, near Iscozacin, to treat construction wood with a copper/chromium/arsenic product, and a cooperative sawmill was built on the same site.

New strips were felled starting in 1988, bringing the treated area to a total of several hectares.

5.4 Project results and outlook

The narrow clear-felled strips resemble scars which the surrounding untouched forest should rapidly recolonize. In fact, careful biological monitoring of these plots or strips confirmed that at Palcazu, as everywhere else, the forest regenerates vigorously if not subjected to fire, grazing and farming.

Strip width influences the diversity of regeneration, which is much higher on the 10-metre outer swath bordering the forest. More than half of the species regenerate by young sprouts and stump shoots, and only 13% of them through strict vegetative regeneration. The shade-demanding species typical of the original forest grow back almost exclusively by shoots, the pioneer species solely by seeding. The mainly light-demanding intermediate species regenerate in both ways.

Unfortunately, pioneer species of no technological value (*Alchornea, Cecropia, Vismia*) represent the vast majority of the regeneration stock and numerous and costly silvicultural treatments will be required if the more important species are to be grown.

All things considered, biological diversity does not seem to be definitely ensured by this system.

The project deserves credit for being relatively innovative, as it was among the first to suggest new approaches (full use of the biomass) involving local populations and motivating them to take up the management of their own forest resources.

However, a number of uncertainties remain:

- the feasibility of organizing the harvest of widely-separated strips;
- the possibility of treating and processing a significant number of trees of all types and categories;
- the outlook for profitable sale of the whole felled biomass;
- the commercial and biological value of the second-growth forest after thirty years.

According to experts, the project requires considerable outside aid to succeed. One of the problems connected with the development of the local cooperative is that it must pay labour to work the forest and needs loans to meet the payroll, as product sales are very laborious and difficult.

Lastly, it must be emphasized that in a continent where young secondary forests are proliferating, the project is neither innovative nor conservancy-minded as regards development of the ecosystem.

Bibliography (SEE PERU in the appendix).

6. CASE STUDY NO. 6: MEXICO

THE QUINTANA ROO PILOT PROJECT

6.1 Overview

Until 1983, the forest in the southern part of the State of Quintana Roo was worked by a logging contractor under a 29-year permit that included both State-owned and city-owned land.

The contractor paid royalties and conducted highly selective logging mainly confined to well-known commercial species: Caoba and Cedar.

Extraction amounted to 20 000 m^3/year and was conducted in a rather disorderly manner over half a million hectares.

This unfortunately classic pattern, followed to the detriment of true regional development and benefiting from laxity on the part inspection bureaus, was completely overhauled in 1983 (when the permit expired, thanks to the work of the former forest research department (INIF), supported by German aid and above all by the felicitous initiative of the State governor.

After the departure of the logging contractor, a "Plan Piloto Forestal" was designed and implemented to organize the development of products and of the existing processing unit, and to establish land uses that would promote an ecological balance compatible with sustained production by and for the benefit of the local population, grouped in forest producers' cooperatives working communal land. In Mexico, this type of group is called an EJIDO.

6.2 The Quintana Roo Forest

This is a semi-deciduous forest with rainfall of 1 200 mm/yr and a dry season lasting from five to seven months. It is located on flat land and is particularly rich in Mahogany (*Swietenia macrophylla*) and Sapodilla (*Manilkara zapota*), species which typify this kind of formation. Historically the forest has been highly disrupted by human activities and cyclones, similarly to what we observed above with regard to the forests of Belize. Chicle, latex and mahogany wood from the two aforementioned species were the cornerstones of the economy in the southern part of the State.

6.3 Goals and principles

The project's primary goal is to help local communities organize themselves to profitably exploit the forest in their territory, so as to avoid the classic pattern of deforestation for shifting cultivation.

This entailed a set of technical goals such as sustained management, the development of a market for lower grade species, and so forth.

In practical terms, aid consisted on the one hand of providing the equipment needed by the Ejidos to work the forests and to supply the existing processing units, and on the other of support for ejido activities by the highly motivated agents of SARH (Secretaría de Agricultura y de Recursos hidraulicos).

Out of the areas's total of 300 000 hectares, the ten ejidos initially involved selected 120 000 on which to conduct their activities, based on a 25-year felling cycle (on a corresponding number of blocks), and no silvicultural treatments.

6.4 Research

Sustained management depends on the ability of Mahogany to regenerate after logging. Findings from current research on regeneration dynamics (heavily supported by British aid) should reorient or influence the basic concepts involved in this operation.

6.5 Status of the Pilot Plan

The numerous results obtained after the project's initial years are difficult to list exhaustively:

- From the technical standpoint, it was possible to fit the ejidos out with the necessary logging equipment, establish limits on soil and forest utilization, make inventories of felling potential and implement reforestation. However, felling, extraction and transport methods have not yet been well mastered.

- Still more important successes were represented by the generation of cash income (for the ejidos), expansion of the range of exploited species (profiting by the commercial appeal of a steady and guaranteed supply of high grade species) and, most important, the creation of an atmosphere of confidence and partnership among the local populations.

The main drawbacks are that it will not be possible to maintain the current logging rate over the long term, expecially as regards the highest grade species, and that silvicultural treatments to improve the growth of logged stands have not been planned or implemented.

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IX. GENERAL SUMMARY - CONCLUSION

Assessment: After the foregoing pages, readers will have to agree that notwithstanding all the numerous research and development projects undertaken here and there in Latin America, in most of the countries tropical forest management exists only in theory, and has practically never been put in practice in the field, though governments require submission of a forest management plan before issuing an logging permit.

Generally speaking, these plans are limited to a resource inventory and a description of harvesting operations and hypothetical silvicultural works. This can be ascribed to several causes: failure to train forestry agents in management, a generally poor undertanding of tested management techniques, and timber companies' lack of interest in long-term forest management set against the quicker profits of intensive logging.

Forest utilization permits vary from country to country, and within any one country depend on criteria such as the size of the exploitable area, the duration of the concession, the logger's obligations to renew the resource, land ownership, and so forth.

This is the case in Costa Rica, for instance, which as of 1983 requires the establishment of management plans; these are of various kinds:

- simple logging contract applicable to farming or grazing areas;
- logging permit applicable to forest areas, with or without the option of changing land use (to farming);
- contract for logging in plantations or in national forest reserves (State property): for simple utilization if the area is less than 100 ha; or
- a management contract if the area is over 100 ha.

Suriname has clearly established silvicultural rules for sustained mangement (the CELOS system;) even if they have not been put into practice, they should serve as an example for other countries.

In Brazil, no logged forests are under large-scale management plans. Research on silviculture and management has shown what problems management plans could encounter. Sustained management seems possible, but interesting a timber company in this activity is a more than formidable task.

In 1987, a trial sale of standing timber in a mapped and inventoried forest for which a mangement plan had been devised was attempted in the Tapajos forest. Only one logging/processing company was interested, and only for an area of 100 ha, because the management costs were dissuasive.

In Bolivia too, attempts at large-scale forest management are thwarted by the absence of research findings and the timber companies' lack of financial interest in the system. One integrated management project is under way in the Chimanes forest.

In Venezuela, all management plans must comply with a certain number of directives and be approved by an Evaluation Committee formed by the Ministry. The directives require demarcation of the exploitation area; resource description (inventory and maps on a scale of 1:10 000 or 1:50 000); determination of the management method, with definition of compartments and silvicultural operations (selective felling and pursuit of natural regeneration or enrichment); registration of operations in a forest registry, and economic assessment.

Current improvements also include marking future crop trees for protection and isolation; map localization of trees to be felled, in order to plan extraction routes; reports on volumes actually extracted (volume tables and verification).

These directives are being applied particularly in the Ticoporo and Imataca forests, notwithstanding conflicts with farming and mining interests.

In Peru the Alexander von Humboldt forest was the subject of a remarkable management plan designed in 1979 with the full support of technical and socio-economic data. Unfortunately, lack of interest in this type of operation has made it impossible to either confirm or dispute the project's validity; perhaps it was too advanced for its times.

The Palcazu site is involved in an integrated pilot management project, where the forest belonging to indigenous rural communities is managed by a local cooperative that combines ownership, logging and processing. However, the model is fragile and requires outside aid.

In Mexico, the most interesting projects are those undertaken by local cooperatives (ejidos) which manage the resources of their "own" forests; the most significant and promising example is the Quintana Roo Plan Piloto Forestal.

Trinidad, which has implemented truly sustained management of its production forests, offers not only an outstanding example but proof positive that forest management is feasible and profitable.

Lastly, the Republic of Guyana is commencing a project of sustainable forest management grounded on solid research.

All things considered, it appears that the present state of knowledge is not insignificant; that numerous scenarios have been tested (with successes and failures); and that whoever the actors, whatever the goals, and wherever the site (in community-owned or State-owned or privately-owned forests), the implementation of mangement plans depends most of all on national and internatinal will and determination.

Conclusion: Tropical America as a whole suffers from the handicaps inherent in all developing countries:

- the problems of survival that face rapidly-growing populations,
- the problems of creating wealth, jobs and expertise in economic development, which become so acute that the concerns or ambitions of forest administration officers are hardly taken into account in a normal context of long-term planning.

On the other hand, a reading of national reports shows that deforestation is a permanent problem that affects all of Latin America's moist tropical forests.

The international public, alerted by conservationists, has taken an attitude towards this problem which may not be entirely rational; initially the most important step is to classify and quantify the phenomenon.

In fact, while excellent botanical and ecological studies have been conducted to determine forest types, there have been no systematic inventories which would provide knowledge of the areas covered by each type, and above all their evolution. There exist only more or less accurate estimates which are regularly quoted in various documents.

On the other hand, the phenomenon of deforestation must be described according to the intended land use; for instance:

- shifting cultivation and the return to a secondary forest which may self-enrich with light-demanding species and gain economic value;

- the trend to pastures, yearly burning and subsequent erosion;

- establishment of permanent crops (coffee, cocoa, agroforestry, etc).

Such a classification would make it possible to measure the ecological impact of deforestation, to determine minimum areas to be set aside as reserves to maintain biodiversity, and lastly, to know the final economic outcome of the two options: conservation/evolution and deforestation.

The phenomenon of deforestion is due in the first instance to the basic political factor of population growth, either on site (in the Isthmus countries), or in the demographic reservoirs consisting of the Andean forest and northeastern Brazil around the Amazonian forest. Faced with this population pressure, the conservation legislation enacted in all these countries and the administrative structures derived therefrom seem altogether ineffective in the field. There are three possible policy options, depending on population density:

(a) The Isthmus countries have in common a high population density that entails problems of fuelwood and timber supply. Land is becoming a scarce input, and the effects of erosion can be considerable. In this context, a policy of setting aside protection forests is imperative, and should be accompanied by intensive forest management and the fostering of agro-forestry activities.

(b) In the Amazonian countries, population density is low in the forest area, which constitutes a de facto reserve of land. Zoning the area on sound scientific bases should make it possible to direct agricultural settlement towards the most fertile lands, develop logging in the permanent forest, and preserve areas which are critical from the standpoint of ecology and biological diversity.

By contrast, there is no problem of clearance for farming in the sparsely populated Guyanese bloc. Forest management is thus essentially a technical problem, and the legislation of Suriname and the Republic of Guyana is adapted to this situation.

This dichotomy, which reflects the difference in population density, is repeated in the silvicultural and management options concerning the desirable forest economy and research projects in these areas.

In the densely populated countries, the pressure on land is high, like the need for wood. Accordingly, here it is necessary to apply intensive silvicultural and management techniques.

By contrast, when population density is lower only extensive techniques are possible, and forest exploitation remains the manager's main tool in the relevant areas. Demarcation, organization and control of concessions should allow large-scale management by annual coupes (as in Trinidad).

From the standpoint of the forest economy, the Isthmus countries are now (or soon will be) facing problems of wood supply. Accordingly, they need to exploit existing forests as effectively as possible in order to reduce wood costs (for instance by extending the logging season to the whole year), and firmly decide for the autarchic option as regards wood products. This will make it possible to develop small wood industries and crafts, increase the return from forest production, and thereby better protect the forest and its ecosystems.

The Amazonian countries, which still have vast forested areas, need to ask themselves whether it is in their best interests or not to maintain or even to develop a classical forestry activity in the tropics, with opportunities for export in some cases. At any rate, it is important to control logging and therefore to acquire (at the national or regional level) the necessary modern tools (remote sensing and radar). It is also necessary to rationalize techniques and circuits in order to increase the timber companies' profit margins, of which a part should go towards a separate national budget for reinvestment in the forests.

As to forestry research, in countries where population density is high it should be aimed at intensive silviculture and regeneration in natural forests. In fact, the considerable demand for wood products allows heavy intervention in the stands, for which the necessary manpower is also available.

In the countries where population density is low, researchers should prefer instead a very extensive approach to forest problems, and work primarly on inventory and control techniques, on measuring the impact of logging and improvement thinning on stands, and on forest uses and products. Researchers should also work in collaboration with the agricultural services to ensure that the development of human activities does not lead to the perhaps irreversible decline of the natural environment.

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